FORT SAM HOUSTON
DINING FACILITIES

San Antonio, Texas

Energy Engineering Analysis Program
(EEAP)

Final Submittal

Conducted by:

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C&B Job No. 91109912F

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
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ENERGY CONSERVATION ANALYSIS

BUILDING 2521 - BOWLING CENTER

Building 2521 is a single story brick facility consisting of 21,000 square feet. This facility contains a small snack bar area which consists of 1,100 square feet.

The operating hours are from 7:00 am to 12:00 am, seven days per week.

The lighting system is primarily fluorescent.

The mechanical system consists of packaged DX rooftop air handling units with gas furnaces.

Hot water is provided to the kitchen by a gas fired water heater. No automatic dishwashing equipment is utilized.

The following ECO's are recommended for Building 2521:

1. IV. A - Night setback/setup thermostat
2. VII. D - Reduce indoor/outdoor lighting to AEI levels
3. IX. A - Replace incandescent lamps with compact fluorescents
4. IX. C - Replace standard lamps with energy saving lamps
5. IX. D - Replace standard ballast with energy saving ballast

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 2521

ECO NO: IV. A.

ECO NAME: Night setback/setup thermostat.

SUMMARY DATA (DEPENDENT):

KWH Savings:	278	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	2.1	MCF/yr
Cost Savings:	$ 17	/yr
Implementation Cost:	$ 122	
Simple Payback:	7.1	Years
Savings to Investment: Ratio (SIR):	1.88	

ECO DESCRIPTION:

Currently, a manual thermostat is used to control the existing air handling unit which serves the snack bar area. This ECO analyzes the installation of a programmable night setback/setup thermostat to reduce energy consumption during unoccupied periods.

COST SAVINGS CALCULATIONS:

(Refer to following SimpCalc)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

MAINTENANCE COSTS:

Maintenance costs of $5.00/year is included in the LCCA for programming, battery replacement and failures.

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

Form	Facility	ECRM Desc.	Page	KWH/Yr	KW	MCF/yr	mmBtu/Yr	$/Yr	Imp.Cost	PayBack
C7-01	BLDG 2521 SNACK BAR	Prog Thermostat	1	278	.00	2.1	3.1	17	121	7.1
		*** SUB-TOTAL ***		278	.00	2.1	3.1	17	121	7.1
	** GRAND TOTAL **			278	.00	2.1	3.1	17	121	7.1

C7-001 Programmable Thermostats - BLDG 2521 SNACK BAR (G)

Cost Source: means cost data

Description: Install night setback/setup thermostat.

A)	.15	BTU/hr-ft-F	U-Value of Walls
B)	608	Sq.Ft.	Wall Area (includes windows and doors)
C)	.05	BTU/hr-ft-F	U-Value of Roof
D)	1104	Sq.Ft.	Roof Area
E)	70	Degree/F	Heating Season Thermostat Setpoint
F)	55	Degree/F	Heating Season Thermostat Setback Setpoint
G)	750	Hours/yr	Heating Season Setback Hours = 5 Hrs/day x 150 Days/yr
H)	74	Degree/F	Cooling Season Thermostat Setpoint
I)	90	Degree/F	Cooling Season Thermostat Setback Setpoint
J)	1000	Hours/yr	Cooling Season Setback Hours = 5 Hrs/day x 200 Days/yr
K)	.7500		Heating Equipment Efficiency (Table 2)
L)	$ 3.41	/MCF	Cost per MCF
M)	8.57	BTUH/Watt	EER of Air Conditioning Unit (Table 1)
N)	$ .0360	/KWH	Cost per KWH - Summer
O)	$ 121		Installed Cost = 1 Thermostats x $ 121/stat
P)	146	BTU/hf-F	Total Envelope UA-Value
Q)	1.6	mmBTU/yr	Heating Load Reduction
R)	$ 7		Heating Cost Reduction
S)	2.3	mmBTU/yr	Cooling Load Reduction
T)	$ 10	/year	Cooling Cost Reduction
U)	$ 17	/year	Annual Cost Savings
V)	7.1	years	Simple Payback

CARTER & BURGESS COST ESTIMATING ANALYSIS

PROJECT NAME: FORT SAM HOUSTON EEAP	PROJECT NO: 91109912F
PROJECT LOCATION: SAN ANTONIO, TEXAS	ESTIMATOR: S.P. CLARK
SUBMITTAL: 35.0%	DATE: 26-Oct-93
ECO NO/ BUILDING: IV. A. / BLDG 2521	CHECKED BY: DJY

TASK DESCRIPTION	QUANTITY		LABOR				MATERIALS		TOTAL COST
	NO/UN	UNIT	MH UN	HRS	UN PRICE	COST	UN PRICE	COST	
						0.00		0.00	0
						0.00		0.00	0
NIGHT SETBACK THERMOSTAT	1	EA			26.50	26.50	64.00	64.00	91
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
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						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
SUBTOTAL						$27		$64	$91
CONTENGENCY	10.00%								$9
OVERHEAD & PROFIT	10.00%								$9
TOTAL									$109

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2521 – ECO IV. A. – NIGHT SETBACK/SETUP THERMOSTAT
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$109		
B. SIOH	$6		
C. DESIGN COST	$7		
D. TOTAL COST (1A+1B+1C)	$122		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$122

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	0.949	$10	11.77	$118
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	2.17	$7	15.34	$110
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. OTHER			$0	11.12	$0
M. DEMAND SAVINGS			$0	11.12	$0
N. TOTAL		3.119	$17		$228

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	($5)		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			($56)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV-INGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) ($56)

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 10.0 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $173

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 1.42

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 6.5%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 2521

ECO NO: VII D & IX A, C, D

ECO NAME: Improve lighting efficiency.

SUMMARY DATA (DEPENDENT):

KWH Savings:	2994	KWH/yr
Demand Savings:	13.3	KW/yr
Gas Savings:	n/a	MCF/yr
Cost Savings:	$ 212	/yr
Implementation Cost:	$ 866	
Simple Payback:	4.1	Years
Savings to Investment: Ratio (SIR):	2.75	

ECO DESCRIPTION:

Currently, low efficiency lighting systems are in use. This ECO will update the lighting systems to improve efficiency while maintaining or increasing the current light levels. The existing lighting system and proposed retrofit action are as follows:

QTY	FIXTURE TYPE	ACTION
2	2-Lamp, 4' Fluor	Retrofit w/T8 lamps and electronic ballasts.
9	4-Lamp, 4' Fluor.	Retrofit w/T8 lamps and electronic ballasts.
10	Incand. downlight	Retrofit with compact fluor. lamps

COST SAVINGS CALCULATIONS:

(Refer to following Flex Output and Lighting Implementation Cost located in Appendix E)

$$
\begin{aligned}
\textit{Demand Savings} &= (2.52\,KW - 1.41\,KW)(4\,mo.x\$7.50/KW + 8\,mo.x\$6.25/KW) \\
&= \$88.8/yr
\end{aligned}
$$

IMPLEMENTATION COSTS:

(Refer to following Flex Output)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

Project Name (*=Base)	Annual Energy kWh	Net Present Value $	Present Value Total LCC $	Annual Value Total LCC $	Annual Energy Savings kWh	Savings Invest. Ratio (SIR)	Levelized Energy Cost cnts/kWh	Total Initial Cost $	Present Value Maint LCC $	Present Value Energy LCC $	Annual Value Maint LCC $	Annual Value Energy LCC $
BLD2521A	1586	4192	7305	537	1249	5.398	3.434	777	467	6061	34	446
*BLD2521B	2835	0	11496	846	0	0.000	0.000	0	660	10836	49	797

Project Description: FT SAM HOUSTON EEAP

File Names	Case Description
BLD2521A	POST RETROFIT CONDITION
BLD2521B	EXISTING CONDITIONS

Whole Building Summary Report

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\2521\BLD2521A.WBR
Date: 10/16/1993

Lighting Annual :	1586	kWh
Lighting Capacity :	1.410	kW
Annual Cooling Effect :	2216	kWh
Annual Heating Effect :	227	kWh
Total Surveyed Floor Area:	1104	SqFt
Percent Survey Completed :	110400	%
Lighting Power Density :	1.277	W/sqft

Costs		Initial	Energy	Maint.	Cooling	Heating	Total
PVLCC	$	777	2817	467	3284	-39	7305
AVLCC	$	57	207	34	242	-3	537

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| Lighting Level Comparison Report |
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Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\2521\BLD2521A.LLR
Date: 10/16/1993

Room Foot Candles	MAX	MIN	AVG	SDEV	MAX Room	MIN Room
Calculated	31.0	19.7	26.6	6.04	1-dining	3-stor
Measured	15.9	0.0	8.1	7.95	3-stor	1-dining
Required	75.0	5.0	31.7	37.86	2-kitchen	1-dining

Foot Candle Comparison	MAX	MIN	AVG	SDEV	MAX Room	MIN Room
Calc - Req.	26.0	-45.9	-5.1	36.91	1-dining	2-kitchen
Meas - Req.	0.9	-66.7	-23.6	37.46	3-stor	2-kitchen

Lighting System Survey Summary
One Page for Each Defined System

ject: FT SAM HOUSTON EEAP
ile: H:\JOB\911099\12F\ELECT\FLEX\OUT\2521\BLD2521A.LSR
Date: 10/16/1993

System Number: 1 Descrip: 4 lamp, 2x4 lay-in

Rooms Served:	1	
Floor Area:	768	SqFt
Possible kW:	1.044	
Working kW:	1.044	
Capacity kW:	1.044	
Lighting:	1175	Annual kWh
Heating:	168	Annual kWh
Cooling:	1641	Annual kWh
Op Hours/Year:	1125	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	237.8	Months
Power Density:	1.359	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	9	36	9.0
Working	9	36	9.0
Capacity	9	36	9.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	2086	114	2432	-29	5080
AVLCC	$	153	8	179	-2	374

System Number: 2 Descrip: 2 lmap 2x4 lay in w/acrylic

ms Served:	1	
loor Area:	120	SqFt
ossible kW:	0.126	
Working kW:	0.126	
Capacity kW:	0.126	
Lighting:	141	Annual kWh
Heating:	20	Annual kWh
Cooling:	197	Annual kWh
Op Hours/Year:	1125	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	237.8	Months
Power Density:	1.047	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	2	4	2.0
Working	2	4	2.0
Capacity	2	4	2.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	251	15	293	-3	637
AVLCC	$	18	1	22	-0	47

System Number: 3 Descrip: PL down light w/balck baffle

Rooms Served:	1	
Floor Area:	216	SqFt
Possible kW:	0.240	
orking kW:	0.240	
acity kW:	0.240	
Lighting:	270	Annual kWh
Heating:	39	Annual kWh
Cooling:	377	Annual kWh
Op Hours/Year:	1125	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	107.0	Months
Power Density:	1.111	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	10	10	10.0
Working	10	10	10.0
Capacity	10	10	10.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	480	338	559	-7	1588
AVLCC	$	35	25	41	-0	117

Room-By-Room Summary Report

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\2521\BLD2521A.RRR
Date: 10/16/1993

Room Name	Floor	#	*	Total Area	#Pr	SYSTEM1 Name	Work Watts	Pot. Watts	Watt sqft	SYSTEM2 Name	Work Watts	Pot. Watts	Watt sqft	SYSTEM3 Name	Work Watts	Pot. Watts	Watt sqft	Work Watts	Pot. Watts	Watt sqft	Meas. FootC	Calc. FootC	Req. FootC
1-dining	1	1	*	768	20	4 lamp, 2x	1044	1044	1.36									1044	1044	1.36	0.0	31.0	5.0
2-kitchen	1	1		216	3	PL down li	240	240	1.11									240	240	1.11	8.3	29.1	75.0
3-stor	1	1		120	1	2 lmap 2x4	126	126	1.05									126	126	1.05	15.9	19.7	15.0

Total Rooms	:	3
Total Area SqFt	:	1104
Total People	:	24
Total Working kW	:	1.410
Total Potential kW	:	1.410
Power Density W/sqft	:	1.277

Whole Building Summary Report

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\2521\BLD2521B.WBR
Date: 10/16/1993

Lighting Annual	:	2835	kWh
Lighting Capacity	:	2.520	kW
Annual Cooling Effect	:	3961	kWh
Annual Heating Effect	:	405	kWh
Total Surveyed Floor Area	:	1104	SqFt
Percent Survey Completed	:	110400	%
Lighting Power Density	:	2.283	W/sqft

Costs		Initial	Energy	Maint.	Cooling	Heating	Total
PVLCC	$	0	5035	660	5870	-69	11496
AVLCC	$	0	371	49	432	-5	846

Lighting System Survey Summary
One Page for Each Defined System

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\2521\BLD2521B.LSR
Date: 10/16/1993

System Number: 1 Descrip: 4 lamp, 2x4 lay-in

Rooms Served:	1	
Floor Area:	768	SqFt
Possible kW:	1.728	
Working kW:	1.728	
Capacity kW:	1.728	
Lighting:	1944	Annual kWh
Heating:	278	Annual kWh
Cooling:	2716	Annual kWh
Op Hours/Year:	1125	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	237.8	Months
Power Density:	2.250	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	9	36	9.0
Working	9	36	9.0
Capacity	9	36	9.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	3453	198	4025	-48	7628
AVLCC	$	254	15	296	-4	561

System Number: 2 Descrip: 2 lmap 2x4 lay in w/acrylic

Rooms Served:	1	
Floor Area:	120	SqFt
Possible kW:	0.192	
Working kW:	0.192	
Capacity kW:	0.192	
Lighting:	216	Annual kWh
Heating:	31	Annual kWh
Cooling:	302	Annual kWh
Op Hours/Year:	1125	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	237.8	Months
Power Density:	1.600	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	2	4	2.0
Working	2	4	2.0
Capacity	2	4	2.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	384	25	447	-5	851
AVLCC	$	28	2	33	-0	63

System Number: 3 Descrip: incand. down light w/balck baffle

Rooms Served:	1	
Floor Area:	216	SqFt
Possible kW:	0.600	
Working kW:	0.480	
Capacity kW:	0.600	
Lighting:	675	Annual kWh
Heating:	96	Annual kWh
Cooling:	943	Annual kWh
Op Hours/Year:	1125	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	10.7	Months
Power Density:	2.222	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	10	10	0.0
Working	10	8	0.0
Capacity	10	10	0.0
Disconnected	0	0	0.0
Broken/Burned	0	2	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	1199	437	1398	-17	3017
AVLCC	$	88	32	103	-1	222

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2521 – ECO VII D. & IX A., C., D. – LIGHTING IMPROVEMENTS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$777		
B. SIOH	$43		
C. DESIGN COST	$47		
D. TOTAL COST (1A+1B+1C)	$866		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$866

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	4.26	$45	11.77	$529
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	0.00	$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. COOLING	$10.55	5.96	$63	11.12	$699
M. DEMAND SAVINGS			$89	11.12	$987
N. TOTAL		10.22	$197		$2,216

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$15		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$167

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV− INGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $167

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 4.1 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $2,382

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 2.75

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 11.3%

ENERGY CONSERVATION ANALYSIS

BUILDING 2530 - CHILD CARE CENTER

Building 2530 is a single story stucco building which is utilized as an elementary education facility. This facility contains a small, 700 square feet kitchen and dining is in the individual classrooms.

The operating hours are 6:00 am to 6:00 pm, Monday thru Friday.

The lighting system is primarily fluorescent.

The mechanical system consists of water source heat pumps served by an evaporative condenser. Heating is provided by a gas fired boiler.

Hot water is provided to the kitchen by the domestic gas fired water heater. Dishwashing is accomplished using an automatic dishwasher with an electric hot water booster heater.

This facility was constructed in 1989 and the design included many energy efficient features. Therefore, the only recommended ECO's for this facility are to improve lighting efficiency (ie. VII. D and IX. B, C, D).

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 2530

ECO NO: VII D & IX B, C, D

ECO NAME: Improve lighting efficiency.

SUMMARY DATA (DEPENDENT):

KWH Savings:	5,444	KWH/yr
Demand Savings:	9.1	KW/yr
Gas Savings:	n/a	MCF/yr
Cost Savings:	$ 280	/yr
Implementation Cost:	$ 591	
Simple Payback:	2.1	Years
Savings to Investment: Ratio (SIR):	5.36	

ECO DESCRIPTION:

Currently, low efficiency lighting systems are in use. This ECO will update the lighting systems to improve efficiency while maintaining or increasing the current light levels. The existing lighting system and proposed retrofit action are as follows:

QTY	FIXTURE TYPE	ACTION
10	4-Lamp, 4' Fluor.	Retrofit w/T8 lamps and electronic ballasts.
1	Incand. Exit	Replace w/LED exit fixture

COST SAVINGS CALCULATIONS:

(Refer to following Flex Output)

$$\textit{Demand Savings} = (1.92KW - 1.16KW)(4mo.x\$7.50/KW + 8mo.\$6.25/KW)$$
$$= \$60.80/yr$$

IMPLEMENTATION COSTS:

(Refer to following Flex Output and Lighting Implementation Cost located in Appendix E)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

Project Name (*=Base)	Annual Energy kWh	Net Present Value $	Present Value Total LCC $	Annual Value Total LCC $	Annual Energy Savings kWh	Savings Invest. Ratio (SIR)	Levelized Energy Cost cnts/kWh	Total Initial Cost $	Present Value Maint LCC $	Present Value Energy LCC $	Annual Value Maint LCC $	Annual Value Energy LCC $
BLD2530A	3480	5949	10308	759	2280	11.223	0.687	530	374	9405	28	692
*BLD2530B	5760	0	16257	1196	0	0.000	0.000	0	691	15566	51	1145

Project Description: FT SAM HOUSTON EEAP

File Names	Case Description
BLD2530A	POST RETROFIT CONDITIONS
BLD2530B	EXISTING CONDITIONS

Whole Building Summary Report

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\2530\BLD2530A.WBR
Date: 10/16/1993

Lighting Annual	:	3480	kWh
Lighting Capacity	:	1.160	kW
Annual Cooling Effect	:	4827	kWh
Annual Heating Effect	:	497	kWh
Total Surveyed Floor Area	:	696	SqFt
Percent Survey Completed	:	69600	%
Lighting Power Density	:	1.667	W/sqft

Costs		Initial	Energy	Maint.	Cooling	Heating	Total
PVLCC	$	530	4014	374	5476	-85	10308
AVLCC	$	39	295	28	403	-6	759

| Lighting Level Comparison Report |

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\2530\BLD2530A.LLR
Date: 10/16/1993

Room Foot Candles	MAX	MIN	AVG	SDEV	MAX Room	MIN Room
Calculated	79.8	32.0	55.9	33.84	1-kitchen	2-stor
Measured	38.3	15.7	27.0	15.98	1-kitchen	2-stor
Required	75.0	7.5	41.3	47.73	1-kitchen	2-stor

Foot Candle Comparison	MAX	MIN	AVG	SDEV	MAX Room	MIN Room
Calc - Req.	24.5	4.8	14.7	13.89	2-stor	1-kitchen
Meas - Req.	8.2	-36.7	-14.3	31.75	2-stor	1-kitchen

Lighting System Survey Summary
One Page for Each Defined System

ject: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\2530\BLD2530A.LSR
Date: 10/16/1993

System Number: 1 Descrip: 4 lamp, 2x4 lay-in

Rooms Served:	2	
Floor Area:	696	SqFt
Possible kW:	1.160	
Working kW:	1.160	
Capacity kW:	1.160	
Lighting:	3480	Annual kWh
Heating:	497	Annual kWh
Cooling:	4827	Annual kWh
Op Hours/Year:	3000	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	116.8	Months
Power Density:	1.667	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	10	40	10.0
Working	10	40	10.0
Capacity	10	40	10.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	4014	374	5476	-85	10308
AVLCC	$	295	28	403	-6	759

Room-By-Room Summary Report

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\2530\BLD2530A.RRR
Date: 10/16/1993

Room Name	Floor	#	*	Total Area	#Pr	SYSTEM1 Name	Work Watts	Pot. Watts	Watt sqft	SYSTEM2 Name	Work Watts	Pot. Watts	Watt sqft	SYSTEM3 Name	Work Watts	Pot. Watts	Watt sqft	Work Watts	Pot. Watts	Watt sqft	Meas. FootC	Calc. FootC	Req. FootC
1-kitchen	1	1	*	576	2	4 lamp, 2x	1044	1044	1.81									1044	1044	1.81	38.3	79.8	75.0
2-stor	1	1		120	0	4 lamp, 2x	116	116	0.97									116	116	0.97	15.7	32.0	7.5

Total Rooms	:	2
Total Area SqFt	:	696
Total People	:	2
Total Working kW	:	1.160
Total Potential kW	:	1.160
Power Density W/sqft	:	1.667

Whole Building Summary Report

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\2530\BLD2530B.WBR
Date: 10/16/1993

Lighting Annual	:	5760	kWh
Lighting Capacity	:	1.920	kW
Annual Cooling Effect	:	7990	kWh
Annual Heating Effect	:	823	kWh
Total Surveyed Floor Area	:	696	SqFt
Percent Survey Completed	:	69600	%
Lighting Power Density	:	2.759	W/sqft

Costs		Initial	Energy	Maint.	Cooling	Heating	Total
PVLCC	$	0	6644	691	9063	-141	16257
AVLCC	$	0	489	51	667	-10	1196

Lighting System Survey Summary
One Page for Each Defined System

ject: FT SAM HOUSTON EEAP
ile: H:\JOB\911099\12F\ELECT\FLEX\OUT\2530\BLD2530B.LSR
ate: 10/16/1993

System Number: 1 Descrip: 4 lamp, 2x4 lay-in

Rooms Served:	2	
Floor Area:	696	SqFt
Possible kW:	1.920	
Working kW:	1.920	
Capacity kW:	1.920	
Lighting:	5760	Annual kWh
Heating:	823	Annual kWh
Cooling:	7990	Annual kWh
Op Hours/Year:	3000	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	116.8	Months
Power Density:	2.759	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	10	40	10.0
Working	10	40	10.0
Capacity	10	40	10.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	6644	691	9063	-141	16257
AVLCC	$	489	51	667	-10	1196

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2530 – ECO VII D. & IX A., B., C., D. – LIGHTING IMPROVEMENTS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$530		
B. SIOH	$29		
C. DESIGN COST	$32		
D. TOTAL COST (1A+1B+1C)	$591		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$591

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	7.78	$82	11.77	$966
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	0.00	$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. COOLING	$10.55	10.8	$114	11.12	$1,267
M. DEMAND SAVINGS			$61	11.12	$678
N. TOTAL		18.58	$257		$2,911

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$23		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$255

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV- INGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $255

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 2.1 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $3,167

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 5.36

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 16.3%

ENERGY CONSERVATION ANALYSIS

BUILDING 2652 - DINNER THEATRE

Building 2652 is a two story brick facility consisting of 31,000 square feet. This facility contains a full service kitchen and a large dinner theatre which consists of 3,600 square feet.

The operating hours are from 10:00 am to 12:00 am, Wednesday thru Saturday.

The lighting system is primarily fluorescent in the kitchen area and incandescent with dimming in the theatre.

The mechanical system consist of fan coil units served by an air cooled chiller. Heating is provided by gas fired duct heaters located in the plenum space above the theatre.

Hot water is provided to the kitchen by a gas fired water heater. Dishwashing is accomplished using an automatic dishwasher with an electric hot water booster heater.

The following ECO's are recommended for Building 2652:

1. IV. C.1) - Add stop/start function to HVAC equipment
2. VII. D - Reduce indoor/outdoor lighting to AEI levels
3. IX. A - Replace incandescent lamps with compact fluorescents
4. IX. B - Replace incandescent exit fixtures with LED
5. IX. C - Replace standard lamps with energy saving lamps
6. IX. D - Replace standard ballast with energy saving ballast

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 2652

ECO NO: IV. C. 1)

ECO NAME: Add stop/start function to HVAC equipment.

SUMMARY DATA (DEPENDENT):

KWH Savings:	41,114	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	39.0	MCF/yr
Cost Savings:	$ 1,613	/yr
Implementation Cost:	$ 2,292	
Simple Payback:	1.4	Years
Savings to Investment: Ratio (SIR):	8.49	

ECO DESCRIPTION:

Presently, the mechanical systems are not controlled during unoccupied times. This ECO analyzes the addition of timeclocks and relays to shut down the HVAC systems during unoccupied hours.

COST SAVINGS CALCULATIONS:

(Refer to following SimpCalc Output)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

MAINTENANCE COSTS:

Maintenance costs of $15/year for each timeclock included in the LCCA for adjustments and failures.

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

Form	Facility	ECRM Desc.	Page	KWH/Yr	KW	MCF/yr	mmBtu/Yr	$/Yr	Imp.Cost	PayBack
C5-01	BLDG 2652 DINNER THEATRE	Timer-A/C-Heat	0	41114	.00	39.0	180.5	1613	2292	1.4
		*** SUB-TOTAL ***		41114	.00	39.0	180.5	1613	2292	1.4
	** GRAND TOTAL **			41114	.00	39.0	180.5	1613	2292	1.4

C5-001 Timeclock Control of Air Cond. / Heating - BLDG 2652 DINNER THEATRE (G)

Cost Source: means cost data

Description: Install time clock to stop/start chiller and AHU's.

A)	55.0	Tons	Cooling Unit Tonnage
B)	896	Hours/yr	Annual Cooling Operating Hours Unit will be Shut Off = 7 Hrs/day x 128 Days/yr
C)	8.63	BTUH/Watt	System EER
D)	.60		Estimated Cooling Load/Duty Factor
E)	560	Hours/yr	Annual Heating Operating Hours Unit will be Shut Off = 7 Hrs/day x 80 Days/yr
F)	100000	BTUH	Heating Unit Output in BTUH
G)	.70		Heating Efficiency
H)	.50		Estimated Heating Load/Duty Factor
I)	$ .0360	/KWH	Cost per KWH - Summer
J)	$ 3.4100	/MCF	MCF Cost
K)	$ 2292		Implementation Cost
L)	41114	KWH/year	Annual Cooling Savings
M)	39	MCF/year	Annual Heating Savings
N)	$ 1613	/year	Annual Cost Savings
O)	1.4	years	Simple Payback

CARTER & BURGESS COST ESTIMATING ANALYSIS

PROJECT NAME: FORT SAM HOUSTON EEAP	PROJECT NO: 91109912F
PROJECT LOCATION: SAN ANTONIO, TEXAS	ESTIMATOR: S.P. CLARK
SUBMITTAL: 35.0%	DATE: 27-Oct-93
ECO NO/ BUILDING: IV. C. 1) / BLDG 2652	CHECKED BY: DJY

TASK DESCRIPTION	QUANTITY		LABOR				MATERIALS		TOTAL COST
	NO/UN	UNIT	MH UN	HRS	UN PRICE	COST	UN PRICE	COST	
						0.00		0.00	0
						0.00		0.00	0
TIME CLOCK	2	EA			44.00	88.00	50.00	100.00	188
RELAYS	8	EA			13.70	109.60	124.00	992.00	1102
CONTROL WIRE	7	CLF			18	126.00	42.50	297.50	424
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
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						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
SUBTOTAL						$324		$1,390	$1,713
CONTENGENCY	10.00%								$171
OVERHEAD & PROFIT	10.00%								$171
TOTAL									$2,056

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2652 – ECO IV. C. 1) – ADD STOP/START FUNCTION TO HVAC EQUIPMENT
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$2,056		
B. SIOH	$113		
C. DESIGN COST	$123		
D. TOTAL COST (1A+1B+1C)	$2,292		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$2,292

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	140.32	$1,480	11.77	$17,424
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	40.21	$133	15.34	$2,042
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. OTHER			$0	11.12	$0
M. DEMAND SAVINGS			$0	11.12	$0
N. TOTAL		180.53	$1,613		$19,466

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	($30)		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			($333)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(–)

	ITEM	SAVINGS(+) COST(–)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV–INGS(+)COST(–)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) ($333)

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 1.4 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $19,133

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 8.35

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 19.8%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 2652

ECO NO: VIII D & IX A, B, C, D

ECO NAME: Improve lighting efficiency.

SUMMARY DATA (DEPENDENT):

KWH Savings:	8,090	KWH/yr
Demand Savings:	11.7	KW/yr
Gas Savings:	n/a	MCF/yr
Cost Savings:	$ 406	/yr
Implementation Cost:	$ 1,588	
Simple Payback:	3.9	Years
Savings to Investment: Ratio (SIR):	2.89	

ECO DESCRIPTION:

Currently, low efficiency lighting systems are in use. This ECO will update the lighting systems to improve efficiency while maintaining or increasing the current light levels. The existing lighting system and proposed retrofit action are as follows:

QTY	FIXTURE TYPE	ACTION
2	2-Lamp, 4" Fluor.	Retrofit w/T8 lamps and electronic ballasts.
12	4-Lamp, 4' Fluor.	Retrofit w/T8 lamps and electronic ballasts.
7	HID Downlight	None.
51	Incandescent downlight	None (diming required).
2	Incandescent exit	Replace w/LED exit fixture

COST SAVINGS CALCULATIONS:

(Refer to following Flex Output)

$$Demand\ Savings = (7.721\,KW - 6.743\,KW)(4\,mo. x \$7.50/KW + 8\,mo. x \$6.25/KW)$$
$$= \$78.24/yr$$

IMPLEMENTATION COSTS:

(Refer to following Flex Output)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

Project Name (*=Base)	Annual Energy kWh	Net Present Value $	Present Value Total LCC $	Annual Value Total LCC $	Annual Energy Savings kWh	Savings Invest. Ratio (SIR)	Levelized Energy Cost cnts/kWh	Total Initial Cost $	Present Value Maint LCC $	Present Value Energy LCC $	Annual Value Maint LCC $	Annual Value Energy LCC $
BLD2652A	23599	7901	72979	5370	3424	5.549	2.007	1424	10368	61187	763	4502
*BLD2657B	27024	0	80880	5951	0	0.000	0.000	0	10857	70022	799	5152

Project Description: FT SAM HOUSTON EEAP

File Names	Case Description
BLD2652A	POST RETROFIT CONDITION
BLD2657B	EXISTING CONDITIONS

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===================================
| Whole Building Summary Report   |
===================================

Project: FT SAM HOUSTON EEAP
   File: H:\JOB\911099\12F\ELECT\FLEX\OUT\2652\BLD2652A.WBR
   Date: 10/16/1993

Lighting Annual          :    23599  kWh
Lighting Capacity        :    6.743  kW
Annual Cooling Effect    :    32331  kWh
Annual Heating Effect    :     3371  kWh
Total Surveyed Floor Area:     2876  SqFt
Percent Survey Completed :   287600  %
Lighting Power Density   :    2.344  W/sqft

Costs     Initial    Energy    Maint.   Cooling   Heating     Total
-----    --------  --------  --------  --------  --------  --------
PVLCC $      1424     25961     10368     35805      -579     72979
AVLCC $       105      1910       763      2635       -43      5370
```

Lighting Level Comparison Report

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\2652\BLD2652A.LLR
Date: 10/16/1993

Room Foot Candles	MAX	MIN	AVG	SDEV	MAX Room	MIN Room
Calculated	70.4	1.6	30.3	21.18	2-serving	7-corr/stor
Measured	40.1	1.0	18.7	15.70	2-serving	7-corr/stor
Required	50.0	5.0	22.1	19.76	3-kitchen	1-dining

Foot Candle Comparison	MAX	MIN	AVG	SDEV	MAX Room	MIN Room
Calc - Req.	50.4	-21.8	8.2	28.20	2-serving	3-kitchen
Meas - Req.	20.1	-29.6	-3.5	15.96	2-serving	3-kitchen

Lighting System Survey Summary
One Page for Each Defined System

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\2652\BLD2652A.LSR
Date: 10/16/1993

System Number: 1 Descrip: incand. down light

Rooms Served:	1	
Floor Area:	840	SqFt
Possible kW:	3.750	
Working kW:	3.750	
Capacity kW:	3.750	
Lighting:	13125	Annual kWh
Heating:	1875	Annual kWh
Cooling:	17875	Annual kWh
Op Hours/Year:	3500	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	2.6	Months
Power Density:	4.464	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	50	50	0.0
Working	50	50	0.0
Capacity	50	50	0.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	14438	8887	19747	-322	42827
AVLCC	$	1062	654	1453	-24	3151

System Number: 2 Descrip: 2x4 fluor. w/acrylic

Rooms Served:	1	
Floor Area:	560	SqFt
Possible kW:	0.116	
Working kW:	0.116	
Capacity kW:	0.116	
Lighting:	406	Annual kWh
Heating:	58	Annual kWh
Cooling:	553	Annual kWh
Op Hours/Year:	3500	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	105.4	Months
Power Density:	0.207	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	1	4	1.0
Working	1	4	1.0
Capacity	1	4	1.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	447	44	611	-10	1144
AVLCC	$	33	3	45	-1	84

System Number: 3 Descrip: HID down light

Rooms Served:	1	
Floor Area:	560	SqFt
Possible kW:	1.435	
Working kW:	1.435	
Capacity kW:	1.435	
Lighting:	5023	Annual kWh
Heating:	717	Annual kWh
Cooling:	7026	Annual kWh
Op Hours/Year:	3500	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	34.6	Months
Power Density:	2.563	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	7	7	7.0
Working	7	7	7.0
Capacity	7	7	7.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	5525	757	7849	-123	14634
AVLCC	$	407	56	578	-9	1077

System Number: 4 Descrip: 2x4 fluor. w/acrylic lens

Rooms Served:	2	
Floor Area:	1136	SqFt
Possible kW:	1.276	
Working kW:	1.276	
Capacity kW:	1.276	
Lighting:	4466	Annual kWh
Heating:	638	Annual kWh
Cooling:	6082	Annual kWh
Op Hours/Year:	3500	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	105.4	Months
Power Density:	1.123	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	11	44	11.0
Working	11	44	11.0
Capacity	11	44	11.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	4913	482	6719	-109	12587
AVLCC	$	362	35	494	-8	926

System Number: 5 Descrip: fluor. wrap

Rooms Served:	2	
Floor Area:	300	SqFt
Possible kW:	0.126	
Working kW:	0.126	
Capacity kW:	0.126	
Lighting:	440	Annual kWh
Heating:	63	Annual kWh
Cooling:	599	Annual kWh
Op Hours/Year:	3500	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	105.4	Months
Power Density:	0.419	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	2	4	2.0
Working	2	4	2.0
Capacity	2	4	2.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	484	59	661	-11	1275
AVLCC	$	36	4	49	-1	94

System Number: 6 Descrip: incand. drum

Rooms Served:	1	
Floor Area:	40	SqFt
Possible kW:	0.040	
Working kW:	0.040	
Capacity kW:	0.040	
Lighting:	140	Annual kWh
Heating:	20	Annual kWh
Cooling:	196	Annual kWh
Op Hours/Year:	3500	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	3.4	Months
Power Density:	1.000	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	1	1	0.0
Working	1	1	0.0
Capacity	1	1	0.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	154	140	219	-3	511
AVLCC	$	11	10	16	-0	38

Room-By-Room Summary Report

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\2652\BLD2652A.RRR
Date: 10/16/1993

Room Name	Floor	#	*	Total Area	#Pr	SYSTEM1 Name	Work Watts	Pot. Watts	Watt sqft	SYSTEM2 Name	Work Watts	Pot. Watts	Watt sqft	SYSTEM3 Name	Work Watts	Pot. Watts	Watt sqft	Work Watts	Pot. Watts	Watt sqft	Meas. FootC	Calc. FootC	Req. FootC
1-dining	1	1	*	840	100	incand. do	3750	3750	4.46									3750	3750	4.46	9.8	39.9	5.0
2-serving	1	1		560	15	HID down l	1435	1435	2.56	2x4 fluor.	116	116	0.21					1551	1551	2.77	40.1	70.4	20.0
3-kitchen	1	1		968	6	2x4 fluor.	1044	1044	1.08									1044	1044	1.08	20.4	28.2	50.0
4-scullery	1	1		168	0	2x4 fluor.	232	232	1.38									232	232	1.38	40.0	29.2	50.0
5-dry stor	1	1		140	1	fluor. wra	63	63	0.45									63	63	0.45	11.7	22.3	10.0
6-stor	1	1		160	0	fluor. wra	63	63	0.39									63	63	0.39	7.7	20.5	5.0
7-corr/sto	1	1		40	0	incand. dr	40	40	1.00									40	40	1.00	1.0	1.6	15.0

Total Rooms	:	7
Total Area SqFt	:	2876
Total People	:	122
Total Working kW	:	6.743
Total Potential kW	:	6.743
Power Density W/sqft	:	2.344

| Whole Building Summary Report |

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\2652\BLD2657B.WBR
Date: 10/16/1993

Lighting Annual	:	27024	kWh
Lighting Capacity	:	7.721	kW
Annual Cooling Effect	:	36994	kWh
Annual Heating Effect	:	3861	kWh
Total Surveyed Floor Area	:	2876	SqFt
Percent Survey Completed	:	287600	%
Lighting Power Density	:	2.685	W/sqft

Costs		Initial	Energy	Maint.	Cooling	Heating	Total
PVLCC	$	0	29728	10857	40957	-662	80880
AVLCC	$	0	2187	799	3014	-49	5951

Lighting System Survey Summary
One Page for Each Defined System

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\2652\BLD2657B.LSR
Date: 10/16/1993

System Number: 1 Descrip: incand. down light

Rooms Served:	1	
Floor Area:	840	SqFt
Possible kW:	3.750	
Working kW:	2.625	
Capacity kW:	3.750	
Lighting:	13125	Annual kWh
Heating:	1875	Annual kWh
Cooling:	17875	Annual kWh
Op Hours/Year:	3500	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	2.6	Months
Power Density:	3.125	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	50	50	0.0
Working	35	35	0.0
Capacity	50	50	0.0
Disconnected	0	0	0.0
Broken/Burned	15	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	14438	8887	19747	-322	42750
AVLCC	$	1062	654	1453	-24	3146

System Number: 2 Descrip: 2x4 fluor. w/acrylic

Rooms Served:	1	
Floor Area:	560	SqFt
Possible kW:	0.192	
Working kW:	0.192	
Capacity kW:	0.192	
Lighting:	672	Annual kWh
Heating:	96	Annual kWh
Cooling:	915	Annual kWh
Op Hours/Year:	3500	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	105.4	Months
Power Density:	0.343	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	1	4	1.0
Working	1	4	1.0
Capacity	1	4	1.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	739	81	1011	-16	1815
AVLCC	$	54	6	74	-1	134

System Number: 3 Descrip: HID down light

Rooms Served:	1	
Floor Area:	560	SqFt
Possible kW:	1.435	
Working kW:	1.230	
Capacity kW:	1.435	
Lighting:	5023	Annual kWh
Heating:	717	Annual kWh
Cooling:	7026	Annual kWh
Op Hours/Year:	3500	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	34.6	Months
Power Density:	2.196	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	7	7	7.0
Working	7	6	6.0
Capacity	7	7	7.0
Disconnected	0	0	0.0
Broken/Burned	0	1	1.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	5525	757	7849	-123	14007
AVLCC	$	407	56	578	-9	1031

System Number: 4 Descrip: 2x4 fluor. w/acrylic lens

Rooms Served:	2	
Floor Area:	1136	SqFt
Possible kW:	2.112	
Working kW:	2.016	
Capacity kW:	2.112	
Lighting:	7392	Annual kWh
Heating:	1056	Annual kWh
Cooling:	10067	Annual kWh
Op Hours/Year:	3500	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	105.4	Months
Power Density:	1.775	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	11	44	11.0
Working	11	42	10.0
Capacity	11	44	11.0
Disconnected	0	0	0.0
Broken/Burned	0	2	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	8132	895	11121	-181	19967
AVLCC	$	598	66	818	-13	1469

System Number: 5 Descrip: fluor. wrap

Rooms Served:	2	
Floor Area:	300	SqFt
Possible kW:	0.192	
rking kW:	0.192	
acity kW:	0.192	
Lighting:	672	Annual kWh
Heating:	96	Annual kWh
Cooling:	915	Annual kWh
Op Hours/Year:	3500	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	105.4	Months
Power Density:	0.640	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	2	4	2.0
Working	2	4	2.0
Capacity	2	4	2.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	739	97	1011	-16	1831
AVLCC	$	54	7	74	-1	135

System Number: 6 Descrip: incand. drum

Rooms Served:	1	
Floor Area:	40	SqFt
Possible kW:	0.040	
Working kW:	0.040	
Capacity kW:	0.040	
Lighting:	140	Annual kWh
Heating:	20	Annual kWh
Cooling:	196	Annual kWh
Op Hours/Year:	3500	Annual Hrs
Re amp Method:	Spot	
mp Time :	3.4	Months
r Density:	1.000	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	1	1	0.0
Working	1	1	0.0
Capacity	1	1	0.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	154	140	219	-3	509
AVLCC	$	11	10	16	-0	37

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2652 – ECO VII D. & IX A., B., C., D. – LIGHTING IMPROVEMENTS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$1,424		
B. SIOH	$78		
C. DESIGN COST	$85		
D. TOTAL COST (1A+1B+1C)	$1,588		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$1,588

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	11.69	$123	11.77	$1,452
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	0.00	$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. COOLING	$10.55	15.92	$168	11.12	$1,868
M. DEMAND SAVINGS			$78	11.12	$870
N. TOTAL		27.61	$370		$4,189

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$36		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$400

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV-INGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $400

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 3.9 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $4,589

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 2.89

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 11.6%

ENERGY CONSERVATION ANALYSIS

BUILDING 2841 - ACADEMY DINING

Building 2841 is four story facility consisting of 363,000 square feet. This facility contains a full service kitchen and a large dining area which consists of 8,300 square feet.

The operating hours are from 10:00 am to 1:00 pm, Monday thru Friday.

The lighting system is primarily fluorescent in the kitchen area and incandescent with dimming in the bar and dining areas.

The mechanical system consists of multi-zone air handling units served by water cooled centrifugal chillers. Heating is provided by gas fired boilers.

Hot water is provided to the kitchen by a gas fired boiler located in the basement. Dishwashing is accomplished using an automatic dishwasher with an electric hot water booster heater.

The following ECO's are recommended for Building 2841:

1. IV. A - Night setback/setup thermostat
2. VII. C - Remove unneeded lamps or fixtures
3. VII. D - Reduce indoor/outdoor lighting to AEI levels
4. IX. A - Replace incandescent lamps with compact fluorescents
5. IX. B - Replace incandescent exit fixtures with LED
6. IX. C - Replace standard lamps with energy saving lamps
7. IX. D - Replace standard ballast with energy saving ballast
8. IX. E - Replace existing fixture with high efficiency fixtures

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 2841

ECO NO: IV. A

ECO NAME: Night setback/setup thermostats

SUMMARY DATA (DEPENDENT):

KWH Savings:	2,000	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	23.5	MCF/yr
Cost Savings:	$ 152	/yr
Implementation Cost:	$ 242	
Simple Payback:	1.6	Years
Savings to Investment: Ratio (SIR):	8.59	

ECO DESCRIPTION:

Currently manual thermostats are used to control the existing multizone air handling unit which serves the dining, kitchen and bar areas. The multizone unit is in operation 24 hours per day.. This ECO analyzes the installation of a programmable night setback/setup thermostat to reduce energy consumption during unoccupied periods.

COST SAVINGS CALCULATIONS:

(Refer to following SimpCalc Output)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

MAINTENANCE COSTS:

Maintenance costs of $5.00/year is included in the LCCA for programming, battery replacement and failures.

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

Form	Facility	ECRM Desc.	Page	KWH/Yr	KW	MCF/yr	mmBtu/Yr	$/Yr	Imp.Cost	PayBack
C7-01	BLDG 2841 ACADEMY DINNING	Prog Thermostat	1	2000	.00	23.5	31.0	152	242	1.6
		*** SUB-TOTAL ***		2000	.00	23.5	31.0	152	242	1.6
	** GRAND TOTAL **			2000	.00	23.5	31.0	152	242	1.6

C7-001 Programmable Thermostats - BLDG 2841 ACADEMY DINNING (G)

Cost Source: means cost data

Description: Install night setback/setup thermostats.

A)	.15	BTU/hr-ft-F	U-Value of Walls
B)	2304	Sq.Ft.	Wall Area (includes windows and doors)
C)	.05	BTU/hr-ft-F	U-Value of Roof
D)	8224	Sq.Ft.	Roof Area
E)	70	Degree/F	Heating Season Thermostat Setpoint
F)	55	Degree/F	Heating Season Thermostat Setback Setpoint
G)	1500	Hours/yr	Heating Season Setback Hours = 10 Hrs/day x 150 Days/yr
H)	74	Degree/F	Cooling Season Thermostat Setpoint
I)	90	Degree/F	Cooling Season Thermostat Setback Setpoint
J)	2000	Hours/yr	Cooling Season Setback Hours = 10 Hrs/day x 200 Days/yr
K)	.7000		Heating Equipment Efficiency (Table 2)
L) $	3.41	/MCF	Cost per MCF
M)	12.12	BTUH/Watt	EER of Air Conditioning Unit (Table 1)
N) $	.0360	/KWH	Cost per KWH - Summer
O) $	242		Installed Cost = 2 Thermostats x $ 121/stat
P)	757	BTU/hf-F	Total Envelope UA-Value
Q)	17.0	mmBTU/yr	Heating Load Reduction
R) $	80		Heating Cost Reduction
S)	24.2	mmBTU/yr	Cooling Load Reduction
T) $	72	/year	Cooling Cost Reduction
U) $	152	/year	Annual Cost Savings
V)	1.6	years	Simple Payback

CARTER & BURGESS COST ESTIMATING ANALYSIS

PROJECT NAME: FORT SAM HOUSTON EEAP	PROJECT NO: 91109912F
PROJECT LOCATION: SAN ANTONIO, TEXAS	ESTIMATOR: S.P. CLARK
SUBMITTAL: 35.0%	DATE: 27-Oct-93
ECO NO/ BUILDING: IV. A. / BLDG 2841	CHECKED BY: DJY

TASK DESCRIPTION	QUANTITY		LABOR				MATERIALS		TOTAL COST
	NO/UN	UNIT	MH UN	HRS	UN PRICE	COST	UN PRICE	COST	
						0.00		0.00	0
						0.00		0.00	0
NIGHT SETBACK THERMOSTAT	2	EA			26.50	53.00	64.00	128.00	181
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
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						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
SUBTOTAL						$53		$128	$181
CONTENGENCY	10.00%								$18
OVERHEAD & PROFIT	10.00%								$18
TOTAL									$217

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2841 – ECO IV. A. – NIGHT SETBACK/SETUP THERMOSTAT
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$217		
B. SIOH	$12		
C. DESIGN COST	$13		
D. TOTAL COST (1A+1B+1C)	$242		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$242

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	6.83	$72	11.77	$848
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	24.23	$80	15.34	$1,230
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. OTHER			$0	11.12	$0
M. DEMAND SAVINGS			$0	11.12	$0
N. TOTAL		31.06	$152		$2,078

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	($10)		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			($111)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(–)

	ITEM	SAVINGS(+) COST(–)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV– INGS(+)COST(–)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) ($111)

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 1.7 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $1,967

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 8.13

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 19.6%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 2841

ECO NO: VII C, D & IX A, B, C, D, E.

ECO NAME: Improve lighting efficiency.

SUMMARY DATA (DEPENDENT):

KWH Savings:	111,658	KWH/yr
Demand Savings:	185.9	KW/yr
Gas Savings:	n/a	MCF/yr
Cost Savings:	$ 6,903	/yr
Implementation Cost:	$ 4,343	
Simple Payback:	.6	Years
Savings to Investment: Ratio (SIR):	18.1	

ECO DESCRIPTION:

Currently, low efficiency lighting systems are in use. This ECO will update the lighting systems to improve efficiency while maintaining or increasing the current light levels. The existing lighting system and proposed retrofit action are as follows:

QTY	FIXTURE TYPE	ACTION
16	2-Lamp, 4' Fluor. cove	Remove all.
241	Incandescent downlight	Remove 139 incandescent fixtures and replace w/52 2-Lamp, 4' Fluor.
12	Fan/Light	None
29	2-Lamp, 4' Fluor	Retrofit w/T8 lamps and electronic ballasts.
34	4-Lamp, 4' Fluor	Retrofit w/T8 lamps and electronic ballasts.
7	Incandescent hood	None.
4	Incandescent exit	Replace with LED exit fixture.

COST SAVINGS CALCULATIONS:

(Refer to following Flex Output)

$$\begin{aligned} \textit{Demand Savings} &= (31.26KW - 15.77KW)(4\,mo.x\$7.50/KW + 8\,mo.x\$6.25/KW) \\ &= \$1{,}239.20/yr \end{aligned}$$

IMPLEMENTATION COSTS:

(Refer to following Flex Output and Lighting Implementation Cost located in Appendix E)

LIFE CYCLE COST ANALYSIS:

Refer to following ECIP Life Cycle Cost Summary)

Project Name (*=Base)	Annual Energy kWh	Net Present Value $	Present Value Total LCC $	Annual Value Total LCC $	Annual Energy Savings kWh	Savings Invest. Ratio (SIR)	Levelized Energy Cost cnts/kWh	Total Initial Cost $	Present Value Maint LCC $	Present Value Energy LCC $	Annual Value Maint LCC $	Annual Value Energy LCC $
BLD2841A	47318	147442	158670	11675	46471	37.856	-3.048	3895	24335	130440	1791	9598
*BLD2841B	93789	0	306112	22524	0	0.000	0.000	0	47481	258631	3494	19030

Project Description: FT SAM HOUSTON EEAP

File Names	Case Description
BLD2841A	POST RETROFIT CONDITION
BLD2841B	EXISTING CONDITIONS

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| Whole Building Summary Report    |
====================================

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\2841\BLD2841A.WBR
Date: 10/17/1993

Lighting Annual           :    47318  kWh
Lighting Capacity         :   15.773  kW
Annual Cooling Effect     :    66331  kWh
Annual Heating Effect     :     6760  kWh
Total Surveyed Floor Area:     8224  SqFt
Percent Survey Completed :   822400  %
Lighting Power Density    :    1.918  W/sqft
```

Costs		Initial	Energy	Maint.	Cooling	Heating	Total
PVLCC	$	3895	54579	24335	77021	-1160	158670
AVLCC	$	287	4016	1791	5667	-85	11675

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| Lighting Level Comparison Report |
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Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\2841\BLD2841A.LLR
Date: 10/17/1993

Room Foot Candles	MAX	MIN	AVG	SDEV	MAX Room	MIN Room
Calculated	28.9	11.5	22.5	7.61	1-bar	2-dining
Measured	37.7	0.0	19.0	17.74	4-kitchen	2-dining
Required	50.0	5.0	24.0	18.81	4-kitchen	2-dining

Foot Candle Comparison	MAX	MIN	AVG	SDEV	MAX Room	MIN Room
Calc - Req.	7.9	-26.0	-1.5	16.36	1-bar	4-kitchen
Meas - Req.	10.0	-12.7	-5.0	10.61	3-serving	1-bar

Lighting System Survey Summary
One Page for Each Defined System

ect: FT SAM HOUSTON EEAP
le: H:\JOB\911099\12F\ELECT\FLEX\OUT\2841\BLD2841A.LSR
ate: 10/17/1993

System Number: 1 Descrip: incand down light

Rooms Served:	1	
Floor Area:	2304	SqFt
Possible kW:	7.650	
Working kW:	7.650	
Capacity kW:	7.650	
Lighting:	22950	Annual kWh
Heating:	3279	Annual kWh
Cooling:	32192	Annual kWh
Op Hours/Year:	3000	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	3.0	Months
Power Density:	3.320	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	102	102	0.0
Working	102	102	0.0
Capacity	102	102	0.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	26472	15539	37399	-563	79004
AVLCC	$	1948	1143	2752	-41	5813

System Number: 3 Descrip: fan light

s Served:	1	
oor Area:	3456	SqFt
ossible kW:	1.920	
Working kW:	1.920	
Capacity kW:	1.920	
Lighting:	5760	Annual kWh
Heating:	823	Annual kWh
Cooling:	8080	Annual kWh
Op Hours/Year:	3000	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	4.0	Months
Power Density:	0.556	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	12	48	0.0
Working	12	48	0.0
Capacity	12	48	0.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	6644	5749	9386	-141	21725
AVLCC	$	489	423	691	-10	1599

System Number: 5 Descrip: 2x4 surface acrylic lens, 2L

Rooms Served:	3	
Floor Area:	5920	SqFt
Possible kW:	5.087	
Working kW:	5.087	
Capacity kW:	5.087	
Lighting:	15260	Annual kWh
Heating:	2180	Annual kWh
Cooling:	21406	Annual kWh
Op Hours/Year:	3000	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	116.8	Months
Power Density:	0.859	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	81	162	81.0
Working	81	162	81.0
Capacity	81	162	81.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	17602	2007	24868	-374	47425
AVLCC	$	1295	148	1830	-28	3490

System Number: 6 Descrip: 2x4 surface acrylic lens, 4L

Rooms Served:	1	
Floor Area:	2304	SqFt
Possible kW:	0.696	
Working kW:	0.696	
Capacity kW:	0.696	
Lighting:	2088	Annual kWh
Heating:	298	Annual kWh
Cooling:	2929	Annual kWh
Op Hours/Year:	3000	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	116.8	Months
Power Density:	0.302	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	6	24	6.0
Working	6	24	6.0
Capacity	6	24	6.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	2408	224	3403	-51	6302
AVLCC	$	177	17	250	-4	464

System Number: 7 Descrip: incand gasketed and enclosed

Rooms Served:	1	
Floor Area:	1320	SqFt
Possible kW:	0.420	
Working kW:	0.420	
Capacity kW:	0.420	
Lighting:	1260	Annual kWh
Heating:	180	Annual kWh
Cooling:	1724	Annual kWh
Op Hours/Year:	3000	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	4.0	Months
Power Density:	0.318	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	7	7	0.0
Working	7	7	0.0
Capacity	7	7	0.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	1453	816	1964	-31	4214
AVLCC	$	107	60	145	-2	310

Room-By-Room Summary Report

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\2841\BLD2841A.RRR
Date: 10/17/1993

Room Name	Floor	#	*	Total Area	#Pr	SYSTEM1 Name	Work Watts	Pot. Watts	Watt sqft	SYSTEM2 Name	Work Watts	Pot. Watts	Watt sqft	SYSTEM3 Name	Work Watts	Pot. Watts	Watt sqft	Work Watts	Pot. Watts	Watt sqft	Meas. FootC	Calc. FootC	Req. FootC
1-bar	1	1	*	2304	100	incand dow	7650	7650	3.32	2x4 surfac	696	696	0.30					8346	8346	3.62	8.3	28.9	21.0
2-dining	1	1		3456	150	fan light	1920	1920	0.56	2x4 surfac	1507	1507	0.44					3427	3427	0.99	0.0	11.5	5.0
3-serving	1	1		1144	10	2x4 surfac	1821	1821	1.59									1821	1821	1.59	30.0	25.6	20.0
4-kitchen	1	1		1320	6	2x4 surfac	1758	1758	1.33	incand gas	420	420	0.32					2178	2178	1.65	37.7	24.0	50.0

Total Rooms	:	4
Total Area SqFt	:	8224
Total People	:	266
Total Working kW	:	15.773
Total Potential kW	:	15.773
Power Density W/sqft	:	1.918

Whole Building Summary Report

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\2841\BLD2841B.WBR
Date: 10/16/1993

Lighting Annual	:	93789	kWh
Lighting Capacity	:	31.263	kW
Annual Cooling Effect	:	131516	kWh
Annual Heating Effect	:	13398	kWh
Total Surveyed Floor Area	:	8224	SqFt
Percent Survey Completed	:	822400	%
Lighting Power Density	:	3.801	W/sqft

Costs		Initial	Energy	Maint.	Cooling	Heating	Total
PVLCC	$	0	108180	47481	152749	-2299	306112
AVLCC	$	0	7960	3494	11240	-169	22524

Lighting System Survey Summary
One Page for Each Defined System

ject: FT SAM HOUSTON EEAP
ile: H:\JOB\911099\12F\ELECT\FLEX\OUT\2841\BLD2841B.LSR
Date: 10/16/1993

System Number: 1 Descrip: incand down light

Rooms Served:	2	
Floor Area:	5760	SqFt
Possible kW:	18.075	
Working kW:	18.075	
Capacity kW:	18.075	
Lighting:	54225	Annual kWh
Heating:	7746	Annual kWh
Cooling:	76062	Annual kWh
Op Hours/Year:	3000	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	3.0	Months
Power Density:	3.138	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	241	241	0.0
Working	241	241	0.0
Capacity	241	241	0.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	62545	36716	88365	-1329	186297
AVLCC	$	4602	2702	6502	-98	13708

System Number: 3 Descrip: fan light

ms Served:	1	
loor Area:	3456	SqFt
ossible kW:	1.920	
Working kW:	1.920	
Capacity kW:	1.920	
Lighting:	5760	Annual kWh
Heating:	823	Annual kWh
Cooling:	8080	Annual kWh
Op Hours/Year:	3000	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	4.0	Months
Power Density:	0.556	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	12	48	0.0
Working	12	48	0.0
Capacity	12	48	0.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	6644	5749	9386	-141	21638
AVLCC	$	489	423	691	-10	1592

System Number: 4 Descrip: strip fluor in cove

Rooms Served:	1	
Floor Area:	3456	SqFt
Possible kW:	1.536	
Working kW:	1.536	
Capacity kW:	1.536	
Lighting:	4608	Annual kWh
Heating:	658	Annual kWh
Cooling:	6464	Annual kWh
Op Hours/Year:	3000	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	116.8	Months
Power Density:	0.444	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	16	32	16.0
Working	16	32	16.0
Capacity	16	32	16.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	5315	659	7509	-113	13370
AVLCC	$	391	48	553	-8	984

System Number: 5 Descrip: 2x4 surface acrylic lens

Rooms Served:	1	
Floor Area:	1144	SqFt
Possible kW:	2.784	
Working kW:	2.640	
Capacity kW:	2.784	
Lighting:	8352	Annual kWh
Heating:	1193	Annual kWh
Cooling:	11715	Annual kWh
Op Hours/Year:	3000	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	116.8	Months
Power Density:	2.308	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	29	58	29.0
Working	29	55	27.0
Capacity	29	58	29.0
Disconnected	0	0	0.0
Broken/Burned	0	3	1.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	9634	1194	13610	-205	24233
AVLCC	$	709	88	1001	-15	1783

System Number: 6 Descrip: 2x4 surface acrylic lens

Rooms Served:	2	
Floor Area:	3624	SqFt
Possible kW:	6.528	
Working kW:	6.384	
Capacity kW:	6.528	
Lighting:	19584	Annual kWh
Heating:	2798	Annual kWh
Cooling:	27471	Annual kWh
Op Hours/Year:	3000	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	116.8	Months
Power Density:	1.762	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	34	136	34.0
Working	34	133	33.0
Capacity	34	136	34.0
Disconnected	0	0	0.0
Broken/Burned	0	3	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	22589	2349	31914	-480	56372
AVLCC	$	1662	173	2348	-35	4148

System Number: 7 Descrip: incand gasketed and enclosed

Rooms Served:	1	
Floor Area:	1320	SqFt
Possible kW:	0.420	
Working kW:	0.420	
Capacity kW:	0.420	
Lighting:	1260	Annual kWh
Heating:	180	Annual kWh
Cooling:	1724	Annual kWh
Op Hours/Year:	3000	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	4.0	Months
Power Density:	0.318	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	7	7	0.0
Working	7	7	0.0
Capacity	7	7	0.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	1453	816	1964	-31	4202
AVLCC	$	107	60	145	-2	309

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2841 – ECO VI C., D. & IX A., B., C., D., E. – LIGHTING IMPROVEMENTS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$3,895		
B. SIOH	$214		
C. DESIGN COST	$234		
D. TOTAL COST (1A+1B+1C)	$4,343		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$4,343

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	158.61	$1,673	11.77	$19,695
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	0.00	$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. COOLING	$10.55	222.48	$2,347	11.12	$26,100
M. DEMAND SAVINGS			$1,239	11.12	$13,780
N. TOTAL		381.09	$5,260		$59,576

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$1,703		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$18,903

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(-)

	ITEM	SAVINGS(+) COST(-)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV-INGS(+)COST(-)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $18,903

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 0.6 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $78,479

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 18.07

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 26.1%

ENERGY CONSTRUCTION ANALYSIS

BUILDING 5105 - DINING HALL

Building 5105 is a single story frame building consisting of 3,400 square feet. This facility consists of a full service kitchen and a large dining area.

The operating hours for this facility are very sporadic due to its use only during troop mobilization (approximately 1 day per month).

The lighting system is primarily fluorescent.

The mechanical system consists of evaporative coolers mounted to the exterior walls. Heating is provided by floor mounted gas furnaces.

Hot water is provided to the kitchen by a gas fired water heater. Dishwashing is accomplished using an automatic dishwasher with an electric hot water booster heater.

Because this facility has very low utilization as described above, there are no feasible ECO's for this facility.

ENERGY CONSERVATION ANALYSIS

BUILDING 5106 - OFFICE BUILDING

Building 5106 is a single story frame building consisting of 3,500 square feet. This facility is no longer utilized as a kitchen and dining facility, therefore it was not analyzed.

ENERGY CONSERVATION ANALYSIS

BUILDING 5107 - DINING HALL

Building 5107 is a single story frame building consisting of 3,400 square feet. This facility consists of a full service kitchen and a large dining area.

The operating hours for this facility are from 5:30 am to 6:30 pm, seven days per week.

The lighting system is primarily fluorescent.

The mechanical system consists of window air conditioners. Heating is provided by floor mounted gas furnaces.

Hot water is provided to the kitchen by a gas fired water heater. Dishwashing is accomplished using an automatic dishwasher with an electric hot water booster heater.

The following ECO's are recommended for Building 5107:

1.	IV. C. 1) -	Add stop/start function to HVAC equipment
2.	VII. D. -	Reduce indoor/outdoor lighting to AEI levels
3.	IX. A -	Replace incandescent lamps with compact fluorescents
4.	IX. B -	Replace incandescent exit fixtures with LED
5.	IX. C -	Replace standard lamps with energy saving lamps
6.	IX. D -	Replace standard ballast with energy saving ballast

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 5107

ECO NO: IV. C. 1

ECO NAME: Add stop/start function for HVAC equipment.

SUMMARY DATA (DEPENDENT):

KWH Savings:	22,613	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	n/a	MCF/yr
Cost Savings:	$ 814	/yr
Implementation Cost:	$ 425	
Simple Payback:	.5	Years
Savings to Investment: Ratio (SIR):	22.56	

ECO DESCRIPTION:

Presently, the mechanical systems are not controlled during unoccupied times. This ECO analyzes the addition of timeclocks and relays to shut down the HVAC systems during unoccupied hours.

COST SAVINGS CALCULATIONS:

(Refer to following SimpCalc Output)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

MAINTENANCE COSTS:

Maintenance costs of $15/year for each timeclock included in the LCCA for adjustments and failures.

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

Form	Facility	ECRM Desc.	Page	KWH/Yr	KW	MCF/yr	mmBtu/Yr	$/Yr	Imp.Cost	PayBack
C5-01	BLDG 5107 DINING	Timer-A/C-Heat	1	22613	.00	94.0	174.0	1135	425	.4
		*** SUB-TOTAL ***		22613	.00	94.0	174.0	1135	425	.4
	** GRAND TOTAL **			22613	.00	94.0	174.0	1135	425	.4

C5-001 Timeclock Control of Air Cond. / Heating - BLDG 5107 DINING (G)

Cost Source: means cost data

Description: Install timmers for 7 window units.

A)	14.0 Tons	Cooling Unit Tonnage
B)	1512 Hours/yr	Annual Cooling Operating Hours Unit will be Shut Off = 8 Hrs/day x 189 Days/yr
C)	6.74 BTUH/Watt	System EER
D)	.60	Estimated Cooling Load/Duty Factor
E)	840 Hours/yr	Annual Heating Operating Hours Unit will be Shut Off = 8 Hrs/day x 105 Days/yr
F)	150000 BTUH	Heating Unit Output in BTUH
G)	.65	Heating Efficiency
H)	.50	Estimated Heating Load/Duty Factor
I)	$ .0360 /KWH	Cost per KWH - Summer
J)	$ 3.4100 /MCF	MCF Cost
K)	$ 425	Implementation Cost
L)	22613 KWH/year	Annual Cooling Savings
M)	94 MCF/year	Annual Heating Savings
N)	$ 1135 /year	Annual Cost Savings
O)	.4 years	Simple Payback

CARTER & BURGESS COST ESTIMATING ANALYSIS

PROJECT NAME: FORT SAM HOUSTON EEAP	PROJECT NO: 91109912F
PROJECT LOCATION: SAN ANTONIO, TEXAS	ESTIMATOR: S.P. CLARK
SUBMITTAL: 35.0%	DATE: 27-Oct-93
ECO NO/ BUILDING: IV. C. 1) / BLDG 5107	CHECKED BY: DJY

TASK DESCRIPTION	QUANTITY		LABOR				MATERIALS		TOTAL COST
	NO/UN	UNIT	MH UN	HRS	UN PRICE	COST	UN PRICE	COST	
						0.00		0.00	0
						0.00		0.00	0
TIME CLOCK	1	EA			44.00	44.00	50.00	50.00	94
TRIPPERS	7	EA			13.70	95.90	0.96	6.72	103
CONTROL WIRE	2	CLF			18	36.00	42.50	85.00	121
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
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						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
SUBTOTAL						$176		$142	$318
CONTENGENCY	10.00%								$32
OVERHEAD & PROFIT	10.00%								$32
TOTAL									$381

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 5107 – ECO IV. C. 1) – ADD STOP/START FUNCTION TO HVAC EQUIPMENT
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$381		
B. SIOH	$21		
C. DESIGN COST	$23		
D. TOTAL COST (1A+1B+1C)	$425		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$425

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	77.18	$814	11.77	$9,584
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	0.00	$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. OTHER			$0	11.12	$0
M. DEMAND SAVINGS			$0	11.12	$0
N. TOTAL		77.18	$814		$9,584

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	–$15		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			–$167

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAVINGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) −$167

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 0.5 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $9,417

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 22.17

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 27.9%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 5107

ECO NO: VII D & IX A, B, C, D

ECO NAME: Improve lighting efficiency.

SUMMARY DATA (DEPENDENT):

KWH Savings:	12,962	KWH/yr
Demand Savings:	18.23	KW/yr
Gas Savings:	n/a	MCF/yr
Cost Savings:	$ 654	/yr
Implementation Cost:	$ 2,119	
Simple Payback:	3.2	Years
Savings to Investment: Ratio (SIR):	3.49	

ECO DESCRIPTION:

Currently, low efficiency lighting systems are in use. This ECO will update the lighting system to improve efficiency while maintaining or increasing lighting levels. The existing lighting system and proposed retrofit action are as follows:

QTY	FIXTURE TYPE	ACTION
46	2-Lamp, 4' Fluor.	Retrofit w/T8 lamps and electronic ballasts.
2	Bare incandescents.	None.
3	Incandescent exit	Replace w/LED exit fixture

COST SAVINGS CALCULATIONS:

(Refer to following Flex Output)

$$\textit{Demand Savings} = (4.976\,KW - 3.457\,KW)(4\,mo. x \$7.50/KW + 8\,mo. x \$6.25/KW)$$
$$= \$121.52/yr$$

IMPLEMENTATION COSTS:

(Refer to following Flex Output and Lighting Implementation Cost located in Appendix E)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

Project Name (*=Base)	Annual Energy kWh	Net Present Value $	Present Value Total LCC $	Annual Value Total LCC $	Annual Energy Savings kWh	Savings Invest. Ratio (SIR)	Levelized Energy Cost cnts/kWh	Total Initial Cost $	Present Value Maint LCC $	Present Value Energy LCC $	Annual Value Maint LCC $	Annual Value Energy LCC $
BLD5107A	12146	12875	36116	2658	5341	6.776	1.388	1900	2622	31594	193	2325
*BLD5107B	17487	0	48992	3605	0	0.000	0.000	0	3515	45476	259	3346

Project Description: FT SAM HOUSTON EEAP

File Names	Case Description
BLD5107A	POST RETROFIT CONDITION
BLD5107B	EXISTING CONDITIONS

Whole Building Summary Report

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\5107\BLD5107A.WBR
Date: 10/16/1993

Lighting Annual	:	12146	kWh
Lighting Capacity	:	3.457	kW
Annual Cooling Effect	:	17339	kWh
Annual Heating Effect	:	1735	kWh
Total Surveyed Floor Area	:	4440	SqFt
Percent Survey Completed	:	444000	%
Lighting Power Density	:	0.778	W/sqft

Costs		Initial	Energy	Maint.	Cooling	Heating	Total
PVLCC	$	1900	13346	2622	18545	-298	36116
AVLCC	$	140	982	193	1365	-22	2658

| Lighting Level Comparison Report |

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\5107\BLD5107A.LLR
Date: 10/16/1993

Room Foot Candles	MAX	MIN	AVG	SDEV	MAX Room	MIN Room
Calculated	24.9	4.2	16.4	7.77	4-kitchen	3-dry stor
Measured	38.3	10.7	24.7	13.12	1-scullery	3-dry stor
Required	75.0	5.0	28.0	32.71	4-kitchen	2-dining

Foot Candle Comparison	MAX	MIN	AVG	SDEV	MAX Room	MIN Room
Calc - Req.	15.4	-50.1	-11.6	29.48	2-dining	4-kitchen
Meas - Req.	23.0	-39.6	-3.3	23.70	2-dining	4-kitchen

Lighting System Survey Summary
One Page for Each Defined System

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\5107\BLD5107A.LSR
Date: 10/16/1993

System Number: 1 Descrip: 4' flour wrap w/acrylic

Rooms Served:	1	
Floor Area:	384	SqFt
Possible kW:	0.314	
Working kW:	0.314	
Capacity kW:	0.314	
Lighting:	1103	Annual kWh
Heating:	158	Annual kWh
Cooling:	1585	Annual kWh
Op Hours/Year:	3514	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	92.4	Months
Power Density:	0.818	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	5	10	5.0
Working	5	10	5.0
Capacity	5	10	5.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	1212	155	1733	-27	3279
AVLCC	$	89	11	127	-2	241

System Number: 2 Descrip: 2x4 rec fluor

Rooms Served:	3	
Floor Area:	3888	SqFt
Possible kW:	2.512	
Working kW:	2.512	
Capacity kW:	2.512	
Lighting:	8827	Annual kWh
Heating:	1261	Annual kWh
Cooling:	12586	Annual kWh
Op Hours/Year:	3514	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	92.4	Months
Power Density:	0.646	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	40	80	40.0
Working	40	80	40.0
Capacity	40	80	40.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	9699	1244	13411	-216	25778
AVLCC	$	714	92	987	-16	1897

System Number: 3 Descrip: 2x2 rec fluor

Rooms Served:	1	
Floor Area:	2880	SqFt
ossible kW:	0.070	
rking kW:	0.070	
acity kW:	0.070	
Lighting:	248	Annual kWh
Heating:	35	Annual kWh
Cooling:	353	Annual kWh
Op Hours/Year:	3514	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	55.5	Months
Power Density:	0.024	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	1	2	1.0
Working	1	2	1.0
Capacity	1	2	1.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	272	40	376	-6	724
AVLCC	$	20	3	28	-0	53

System Number: 4 Descrip: bare incand

Rooms Served:	1	
Floor Area:	168	SqFt
Possible kW:	0.200	
Working kW:	0.200	
Capacity kW:	0.200	
Lighting:	703	Annual kWh
Heating:	100	Annual kWh
Cooling:	1010	Annual kWh
Op Hours/Year:	3514	Annual Hrs
amp Method:	Spot	
mp Time :	2.6	Months
r Density:	1.190	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	2	2	0.0
Working	2	2	0.0
Capacity	2	2	0.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	772	364	1104	-17	2226
AVLCC	$	57	27	81	-1	164

System Number: 5 Descrip: hood incand.

Rooms Served:	1	
Floor Area:	768	SqFt
Possible kW:	0.360	
Working kW:	0.360	
Capacity kW:	0.360	
Lighting:	1265	Annual kWh
Heating:	181	Annual kWh
Cooling:	1804	Annual kWh
Op Hours/Year:	3514	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	3.4	Months
Power Density:	0.469	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	6	6	0.0
Working	6	6	0.0
Capacity	6	6	0.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	1390	819	1922	-31	4110
AVLCC	$	102	60	141	-2	302

| Room-By-Room Summary Report |

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\5107\BLD5107A.RRR
Date: 10/16/1993

Room Name	Floor	#	*	Total Area	#Pr	SYSTEM1 Name	Work Watts	Pot. Watts	Watt sqft	SYSTEM2 Name	Work Watts	Pot. Watts	Watt sqft	SYSTEM3 Name	Work Watts	Pot. Watts	Watt sqft	Work Watts	Pot. Watts	Watt sqft	Meas. FootC	Calc. FootC	Req. FootC
1-scullery	1	1	*	384	1	4' flour w	314	314	0.82									314	314	0.82	38.3	14.8	50.0
2-dining	1	1		2880	200	2x4 rec fl	1758	1758	0.61	2x2 rec fl	71	71	0.02					1829	1829	0.64	28.0	20.4	5.0
3-dry stor	1	1		168	0	bare incan	200	200	1.19									200	200	1.19	10.7	4.2	5.0
4-kitchen	1	1		768	5	2x4 rec fl	565	565	0.74	hood incan	360	360	0.47					925	925	1.20	35.4	24.9	75.0
5-stor	1	1		240	0	2x4 rec fl	188	188	0.78									188	188	0.78	11.2	17.7	5.0

Total Rooms	:	5
Total Area SqFt	:	4440
Total People	:	206
Total Working kW	:	3.457
Total Potential kW	:	3.457
Power Density W/sqft	:	0.778

```
==================================
| Whole Building Summary Report  |
==================================

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\5107\BLD5107B.WBR
Date: 10/16/1993

Lighting Annual          :    17487  kWh
Lighting Capacity        :    4.976  kW
Annual Cooling Effect    :    24961  kWh
Annual Heating Effect    :     2498  kWh
Total Surveyed Floor Area:     4440  SqFt
Percent Survey Completed :   444000  %
Lighting Power Density   :    1.121  W/sqft

Costs    Initial    Energy    Maint.   Cooling   Heating     Total
-----   --------  --------  --------  --------  --------  --------
PVLCC $        0     19215      3515     26690      -429     48992
AVLCC $        0      1414       259      1964       -32      3605
```

Lighting System Survey Summary
One Page for Each Defined System

ject: FT SAM HOUSTON EEAP
ile: H:\JOB\911099\12F\ELECT\FLEX\OUT\5107\BLD5107B.LSR
Date: 10/16/1993

System Number: 1 Descrip: 4' flour wrap w/acrylic

Rooms Served:	1	
Floor Area:	384	SqFt
Possible kW:	0.480	
Working kW:	0.480	
Capacity kW:	0.480	
Lighting:	1687	Annual kWh
Heating:	241	Annual kWh
Cooling:	2423	Annual kWh
Op Hours/Year:	3514	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	92.4	Months
Power Density:	1.250	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	5	10	5.0
Working	5	10	5.0
Capacity	5	10	5.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	1853	251	2649	-41	4712
AVLCC	$	136	18	195	-3	347

System Number: 2 Descrip: 2x4 rec fluor

ms Served:	3	
loor Area:	3888	SqFt
Possible kW:	3.840	
Working kW:	3.552	
Capacity kW:	3.840	
Lighting:	13494	Annual kWh
Heating:	1928	Annual kWh
Cooling:	19240	Annual kWh
Op Hours/Year:	3514	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	92.4	Months
Power Density:	0.914	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	40	80	40.0
Working	40	74	37.0
Capacity	40	80	40.0
Disconnected	0	0	0.0
Broken/Burned	0	6	3.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	14827	2007	20501	-331	37004
AVLCC	$	1091	148	1508	-24	2723

System Number: 3 Descrip: 2x2 rec fluor

Rooms Served:	1	
Floor Area:	2880	SqFt
Possible kW:	0.097	
rking kW:	0.097	
acity kW:	0.097	
Lighting:	339	Annual kWh
Heating:	48	Annual kWh
Cooling:	484	Annual kWh
Op Hours/Year:	3514	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	55.5	Months
Power Density:	0.034	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	1	2	1.0
Working	1	2	1.0
Capacity	1	2	1.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	373	74	515	-8	954
AVLCC	$	27	5	38	-1	70

System Number: 5 Descrip: bare incand

Rooms Served:	1	
Floor Area:	168	SqFt
Possible kW:	0.200	
Working kW:	0.200	
Capacity kW:	0.200	
Lighting:	703	Annual kWh
Heating:	100	Annual kWh
Cooling:	1010	Annual kWh
Op Hours/Year:	3514	Annual Hrs
Relamp Method:	Spot	
mp Time :	2.6	Months
r Density:	1.190	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	2	2	0.0
Working	2	2	0.0
Capacity	2	2	0.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	772	364	1104	-17	2222
AVLCC	$	57	27	81	-1	164

System Number: 6 Descrip: hood incand.

Rooms Served:	1	
Floor Area:	768	SqFt
Possible kW:	0.360	
Working kW:	0.360	
Capacity kW:	0.360	
Lighting:	1265	Annual kWh
Heating:	181	Annual kWh
Cooling:	1804	Annual kWh
Op Hours/Year:	3514	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	3.4	Months
Power Density:	0.469	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	6	6	0.0
Working	6	6	0.0
Capacity	6	6	0.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	1390	819	1922	-31	4100
AVLCC	$	102	60	141	-2	302

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 5107 – ECO VII D. & IX A., B., C., D. – LIGHTING IMPROVEMENTS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$1,900		
B. SIOH	$105		
C. DESIGN COST	$114		
D. TOTAL COST (1A+1B+1C)	$2,119		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$2,119

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	18.23	$192	11.77	$2,264
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	0.00	$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. COOLING	$10.55	26.01	$274	11.12	$3,051
M. DEMAND SAVINGS			$122	11.12	$1,351
N. TOTAL		44.24	$588		$6,666

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$66		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$733

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(-)

	ITEM	SAVINGS(+) COST(-)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV-INGS(+)COST(-)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $733

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 3.2 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $7,399

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 3.49

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 13.0%

ENERGY CONSERVATION ANALYSIS

BUILDING 5114 - DINING HALL

Building 5114 is a single story frame building consisting of 3,400 square feet. This facility consists of a full service kitchen and a large dining area.

The operating hours for this facility are very sporadic due to its use only during troop mobilization (approximately 1 day per month).

The lighting system is primarily fluorescent.

The mechanical system consists of evaporative coolers mounted to the exterior walls. Heating is provided by floor mounted gas furnaces.

Hot water is provided to the kitchen by a gas fired water heater. Dishwashing is accomplished using an automatic dishwasher with an electric hot water booster heater.

Because this facility has very low utilization as described above, there are no feasible ECO's for this facility.

ENERGY CONSERVATION ANALYSIS

BUILDING 5124 - DINING HALL

Building 5124 is a single story frame building consisting of 3,400 square feet. This facility consists of a full service kitchen and a large dining area.

The operating hours for this facility are very sporadic due to its use only during troop mobilization (approximately 1 day per month).

The lighting system is primarily fluorescent.

The mechanical system consists of evaporative coolers mounted to the exterior walls. Heating is provided by floor mounted gas furnaces.

Hot water is provided to the kitchen by a gas fired water heater. Dishwashing is accomplished using an automatic dishwasher with an electric hot water booster heater.

Because this facility has very low utilization as described above, there are no feasible ECO's for this facility.

A - UTILITY RATE SCHEDULES

City Public Service
of
San Antonio, Texas

RECEIVED
CARTER & BURGESS, INC.
1 1993

September 14, 1993

Mr. Scott Clark
Carter And Burgess Engineering
3880 Hulen
Ft. Worth, Texas 76107-7254

Dear Mr. Clark:

Per our telephone conversation on September 13, 1993, I have enclosed the rate schedules applicable to gas and electric service for Ft. Sam Houston.

Also I have included consumption histories for the primary gas and electric accounts.

I hope this information will serve your needs and if you have any further questions call me at (210) 978-4760.

Sincerely,

Charles E. Neumann

Charles E. Neumann
Senior Commercial Representative
Energy Survey Section

CEN:jal

Enclosures

Navarro at Villita/P.O. Box 1771 San Antonio, Texas 78296 (512) 227-3211

Effective January 31, 1991

CITY PUBLIC SERVICE BOARD

OF SAN ANTONIO

RATE 41

LARGE LIGHTING AND POWER SERVICE

ELECTRIC RATE

LLP

APPLICATION

This rate is applicable to alternating current service to any Customer whose entire requirements on the premises are supplied at one point of delivery through one meter.

This rate is not applicable (a) when another source of electric energy is used by the Customer or (b) when another source of energy (other than electric) is used for the same purpose or an equivalent purpose as the electric energy furnished directly by City Public Service, except that such other source of energy as mentioned in (a) and (b) may be used during temporary failure of the City Public Service electric service.

This rate is not applicable to emergency, temporary, or shared service. It is also not applicable to resale service except that submetering will be permitted under this rate only for the purpose of allocating the monthly bill among the tenants served through a master meter in accordance with City Public Service and Regulations Applying to Electric Service.

TYPE OF SERVICE

The types of service available under this rate are described in City Public Service Electric Service Standards. When facilities of adequate capacity and suitable phase and voltage are not adjacent to the premises served or to be served, the required service may be provided pursuant to City Public Service Rules and Regulations Applying to Electric Service and the City Public Service Board Policy for Electric Line Extensions and Service Connections.

MONTHLY BILL

<u>Rate</u>

$ 130.00	Service Availability Charge
	<u>Demand Charge</u>
	Summer Billing (June - September)
$ 7.50	Per KW for all KW of Billing Demand
	Non-Summer Billing (October - May)
$ 6.25	Per KW for all KW of Billing Demand
	<u>Energy Charge</u>
$ 0.0380	Per KWH for the first 200 KWH per KW of Billing Demand
$ 0.0360	Per KWH for all additional KWH

<u>Minimum Bill</u>

The Minimum Bill shall be equal to the Service Availability Charge plus the Demand Charge (Summer Billing or Non-Summer Billing as the case may be) or such higher Minimum Bill as may be specified in the Customer's Application and Agreement for Electric Service. The Minimum Bill is not subject to reduction by credits allowed under the adjustments below.

<u>Adjustments</u>

Plus or minus an amount which reflects the difference in the unit fuel cost factor for the current month above or below a basic cost of $0.0160 per KWH sold. The unit fuel cost factor for the current month is computed as the sum of:

a) the maximum billing demand (CCF/Day) as established during the previous winter period months of December through March
b) 600 CCF/Day
c) such higher demand (CCF/Day) as may be specified in the Customer's Application and Agreement for Gas Service.

For new customers having no winter CCF usage history, the billing demand (CCF/Day) as defined above shall be equal to the greater of (b) or (c) as defined herein.

Minimum Bill

The Minimum Bill shall be equal to the Service Availability Charge plus the Demand Charge (Winter Billing or Non-Winter Billing as the case may be) or such higher Minimum Bill as may be specified in the Customer's Application and Agreement for Gas Service. The Minimum Bill is not subject to reduction by credits allowed under the adjustments below.

Adjustments

Plus or minus an amount which reflects the difference in the unit gas cost factor for the current month above or below a basic cost of $0.220 per CCF sold. The unit gas cost factor for the current month is computed as the sum of:

(a) The current month's estimated unit gas cost per CCF, which is computed based upon the current month's estimated CCF purchases, unit gas cost by supplier, any known changes in gas cost, and pipeline losses; plus

(b) An adjustment, if indicated by the current status of the over and under recovery of gas costs for the recovery year in progress, to correct for the difference between the preceding month's estimated unit gas cost and the current computation for this value. This adjustment is computed by multiplying the difference between the preceding month's estimated unit gas cost (corrected for any gas supplier surcharge) and the current computation for this value times the CCF purchased during the preceding month and then dividing the result by the current month's estimated CCF sales; plus

(c) An adjustment, if indicated by the current status of the over and under recovery of gas costs for the recovery year in progress, to correct for the difference between the preceding month's estimated value for the second preceding month's unit gas cost and actual unit gas cost for that month. This adjustment is computed by multiplying the difference between the preceding month's estimated value for the second preceding month's unit gas cost and the actual unit gas cost for that month (corrected for any gas supplier surcharge) times the CCF purchased during the preceding month and then dividing the result by the current month's estimated CCF sales; plus

(d) An adjustment, as necessary, which may be derived and applied to the unit gas cost factors during the months preceding, including, and/or following August each year, depending on the dollar amount of adjustment necessary to balance the annual cumulative actual gas cost with the annual cumulative gas cost recovery through these rates; plus

(e) An adjustment to reflect offsetting credits to or additions to gas costs resulting from judicial orders or settlements of legal proceedings affecting gas costs or components thereof, including taxes or transportation costs, or to reflect accounting and billing record corrections or other out-of-period adjustments to gas costs.

Plus or minus the proportionate part of the increase or decrease in taxes, required payments to governmental entities or for governmental or municipal purposes which may be hereafter assessed, imposed, or otherwise required and which are payable out of or are based upon revenues of the gas system.

LATE PAYMENT CHARGE

The Monthly Bill will be charged if payment is made within the period indicated on the bill. Bills not paid within this period will be charged an additional 2 percent times the Monthly Bill excluding the adjustment for gas costs, garbage fees and sales taxes.

TERM OF SERVICE

Service shall be supplied for an initial period of not less than one year and shall be continued from year to year unless a longer period is specified in the City Public Service Application and Agreement for Gas Service.

RULES AND REGULATIONS

Service is subject to City Public Service Rules and Regulations Applying to Gas Service which are incorporated herein by this reference.

CURTAILMENT

City Public Service shall have the right at any and all times to immediately adjust in whole or in part, the supply of gas to Customers, in order to adjust to gas supplies available for resale or to adjust to other factors affecting delivery capability.

07996651 2U S GOVERNMENT SUBSTATION THREE SUB 3 782000000 23

RANDOLPH AFB TX 781504321 1 1201 0000000 07 6

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78546256 000 000 000 SUB STA ON SCHOFIELD NEAR CREEK RD LSN 0000000000

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777395820 806736792943100 000000280000010930576400 137592030576305762956828889624192214481764017640176401764018430

30721002396 8YYY 0085 00 291164640007854625 6 301158760007691312 8 3211489600072653468 8 301139600

AUG '93 JULY JUNE MAY

291 935200047231393 321 882000042271360 291 834400038751704 351 938000043689700 311 901600041338400 311108360004793272

APR MAR FEB JAN DEC NOV

291124040005900276 0 3011528800071509408 2911498000068300020

OCT. SEPT. AUG. '92

541

405798730721 769131281 0 215204930806 -769131285 5 215124930903 -785462565 5

#LCT

CMR REQUESTED BY OP IZ

MAIL ADDR: 266 F ST W

MAIL OVFL: HQ ATC CEUF-CUF BLDG 90

968716001 Rev 7-84

CUSTOMER MASTER RECORD

0799721113 29 S GOVERNMENT

FT SAM HOUSTON

RANDOLPH AFB TX 781504321

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1597324 9526 1629576 0000000240000016016565624 00001000

ACTUAL DEMAND HISTORY

384	384	1440	1488	1464	1392	1344	1344	1320	1512	1632	1656	1656	1

CONSUMPTION HISTORY

	Days	Consumption	Bill Amt
AUG 93	343	194400	1607150
JULY	301	180000	1569040
JUNE	323	482400	2953079
MAY	301	880800	4042206
APR	291	804000	3779344
MAR	311	823200	3477549
FEB	291	741600	3047534
JAN	351	873600	3596958
DEC	311	772800	3202696
NOV	311	864000	3501568
OCT	291	873600	3885024
SEPT.	301	981600	4526666
AUG	291	955200	4317501

00 (days)

0546247000006500006500002400000002400 5 0001693082401 546235

TRANSACTION TRAILER

408 930723 156904010 215204930809 -156904055 145227930901 0000
855 930901 0000 005922930908 000102005922930908 0000101

SERV OVFL: BURR RD

CMR REQUESTED BY OP IZ

MAIL ADDR: 266 F ST W

MAIL OVFL: HQ ATC/CEUF-CUR BLDG 901

091493009

16001 Rev 7/84

CITY PUBLIC SERVICE BOARD

OF SAN ANTONIO

RATE 1B

LARGE VOLUME

GAS RATE

LVG

APPLICATION

This rate is applicable to gas service supplied through one metering station for fuel used (a) for commercial services, (b) for industrial, manufacturing or processing purposes, or for steam generation for power purposes, including auxiliary apparatus used exclusively for manufacturing or processing purposes, or (c) for heating and/or cooling plants.

This rate is not applicable to gas supplied for:

(1) standby service
(2) resale
(3) single family residential units.

TYPE OF SERVICE

Natural gas will be supplied at a nominal gauge pressure of four ounces per square inch. If natural gas is metered at a pressure higher than four ounces, measurements will be adjusted to the equivalent of four ounces. When mains of adequate capacity and suitable pressure are not adjacent to the premises served or to be served, the required service may be provided pursuant to City Public Service Rules and Regulations Applying to Gas Service and the City Public Service Board Policy for Gas Main Extensions and Service Connections.

MONTHLY BILL

Rate

$325.00	Service Availability Charge
	Demand Charge
	Winter Billing (December-March)
$ 0.80	Per CCF/Day of Billing Demand
	Non-Winter Billing (April-November)
$ 0.64	Per CCF/Day of Billing Demand
	Energy Charge
$ 0.265	Per CCF for all CCF
	1 CCF equals 100 cubic feet

Billing Demand

For the winter period December through March, the Billing Demand (CCF/Day) shall be equal to the greatest of the following:

a) the monthly metered consumption divided by days in the billing period
b) 600 CCF/Day
c) such higher demand (CCF/Day) as may be specified in the Customer's Application and Agreement for Gas Service.

For the non-winter period April through November, the Billing Demand (CCF/Day) shall be equal to the greatest of the following:

CUSTOMER MASTER RECORD

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000 BITTIMAN E OF
FI SAM HSTN TX 782340000 1 201 0000000 0 ENTR 01
782000000 23 U2 0000000
00035 000000000000 0000000001000 FV N
302626 000 302626 000
00000000000006300000000 00000000 930823 749726 930909
0221 0 28 1 2 30000000

M	00337?	5
M	003949	5
M	003815	5
M	000686	5

50089050[illegible]7407229308[illegible]050000 5 3 1800001000000000000000 3070217182920600812000
500890503740722930908510600000 5 3 1800001000000000000000 3020730182920600812000
500890502740722930823510600000 5 3 1800001000000000000000 3020971182920600812000
500890502740722930823480900000 5 3 1000001000000000000000 3087804182920600812000

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284727	17839	284727	000

014707	006305000080	0	00
014707	006106000080	0	00
014707	005606000080	0	00
014707	004809000080	0	00

Month	Days	Consumption	Bill Amt
8/93	313	00	000
	363	52	000
	313	4741	000
	313	1525	302626
7/93	303	00	000
	363	252	000
	303	3432	000
	303	3069	286396
6/93	273	00	000
	353	97	000
	303	4098	000
	303	4134	342810
5/93	293	00	000
	263	126	000
	323	5170	000
	323	5941	512893
4/93	353	753	000
	351	302	000
	293	6599	000
	29?	7163	573498
3/93	291	4941	000
	291	3907	000
	291	9855	000
	291	11045	862058
2/93	291	7490	000
	291	6850	000
	291	11582	000
	291	12965	982965
1/93	341	8777	000
	341	7516	000
	341	13771	000
	341	14716	1440645
12/92	341	8537	000
	341	7151	000
	341	13473	000
	341	14645	1426678
11/92	261	2281	000
	291	726	000
	291	6770	000
	291	7666	643655
10/92	323	287	000
	293	73	000
	293	4694	000
	293	4850	487620
9/92	321	2300	000
	321	09	000
	321	5104	000
	321	2656	426729
8/92	291	2497	000
	291	03	000
	291	4463	000
	291	1801	380702

TRANSACTION TRAILER
405792930804 28635610 195922930813 -11880058 215102930823 -16759655

SERV OVFL:H WURZ,VILLAGE I#HE

CMR REQUESTED BY OP IZ
MAIL MODE: UTL OPERATION OFFICE
MAIL OVFL: D F A E
091493009

CUSTOMER MASTER RECORD

1076005010 SUE GOVT

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FT SAM HSTN TX 782340000

7820000000 25 ... 000000000

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302626 000 302626 000

M 003949 5	50089050374072293090851060000	5	3	8000010000000000000000	3020730182920600812000
M 003815 5	50089050274072293082351060000	5	3	8000010000000000000000	3020971182920600812000
M 000666 5	50089050274072293082348090000	5	3	1000001000000000000000	3087904182920600812000

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284727	17919	284727	000

				8/93			7/93			6/93			5/93	
014707	006305000080	0	00	313	00	000	303	00	000	273	00	000	293	00	000
014707	006106000080	0	00	363	52	000	363	252	000	353	97	000	263	126	000
014707	005606000080	0	00	313	4741	000	303	3432	000	303	4098	000	323	5170	000
014707	004809000080	0	00	313	1525	302626	303	3069	286396	303	4134	342810	323	5941	512893

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293	6599	000	291	9855	000	291	11582	000	341	13771	000	341	13473	000	291	6770	000
293	7163	5...	291	11045	862058	291	12965	982965	341	14716	1440645	341	14645	1426678	291	7666	643855

	10/92			9/92			8/92	
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293	72	000	321	09	000	291	03	000
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TRANSACTION TRAILER

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SERV OVFL:M WURZ VILLAGE I#HR

CHR REQUESTED BY OP IZ

MAIL ADDR: UTL OPERATION OFFICE

MAIL OVFL: D F A E

091493009

968 16001 Rev 7-84

CUSTOMER MASTER RECORD

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295	1168	216100	291	9695	591853	291	14074	728201	351	15310	1008100	331	9437	654978	291	1135	170272

291	1563	000	321	1615	000	291	1584	000
291	705	153720	321	753	151541	291	728	147580

TRANSACTION TRAILER

405791930723 164595 10 215102930823 -16459555

#HP

CMR REQUESTED BY OP IZ

MAIL ADDR: UTIL OPERATIONS OFF

MAIL OVFL: DFAE-BLDG 1191

091493009

CUSTOMER MASTER RECORD

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ACTUAL DEMAND HISTORY

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405990930723 | 2191 3710 | 215 102930823 | -21913755

#HP

SERV OVFL: CENTRAL HEAT PLT

CMR REQUESTED BY OF 12

MAIL ADDR: DFAE-UTIL OPERATION

MAIL OVFL: OFFICE-BLDG 1191

091493009

CUSTOMER MASTER RECORD

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SERV OVFL: POST LDRY

MAIL ADDR: UTIL OPERATIONS OFF

CMR REQUESTED BY OF IZ

MAIL OVFL: DFAE-BLDG 1191

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CUSTOMER MASTER RECORD

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							2178	214509

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SERV OVFL:FSH-WHERRY HSING##

CMR REQUESTED BY OP IZ

MAIL ADDR: UTL OPERATION OFFICE

MAIL OVFL: D F A E

091493002

CU[obscured]ER MASTER RECORD

1377 ESH NTRAL

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291	2655	296588	321	2927	298728	291	2712	281116

4055999 30723 2765151 2151029 30823 -27651555

#HP CE

SERV. OVFL: ENERGY PLANT

CMR REQUESTED BY OP 17

MAIL ADDR: UTIL OPERATIONS OFF

MAIL OVFL: DFAE-BLOG 1191

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CU[hole-punched]MER MASTER RECORD

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ACTUAL DEMAND HISTORY

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291	2949	271240	321	3188	241742	291	2960	225718

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#HP

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MAIL ADDR: UTIL OPERATIONS OFF

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B - NON-RECOMMENDED ECO'S

GENERAL

I. ENVELOPE

A. Additional Insulation/Sealing

- Not recommended except as Maintenance and Operation (M&O) for Building 368. Existing insulation is adequate and additional insulation is not feasible.

B. Insulated Glass or Double Glazing

- Not recommended because of high cost and limited benefit as a result of too few windows, many of them with overhangs and internal shading.

C. Weather Striping and Caulking

- Not recommended due to good condition of existing weather striping and caulking. Should remain part of regular M&O procedures.

II. HOT WATER

A. Shutdown Energy to Water Heater

- Not recommended due to growth of legionella pneumophila. (See following ASHRAE HVAC Applications, 1991, page 44.7)

B. Addition of Booster Heaters

- Booster heaters currently exist on all rinse sinks and dishwashers.

- The existing sequence of control is for the water heater to provide 140°F, boosted to 180°F by electric boosters.

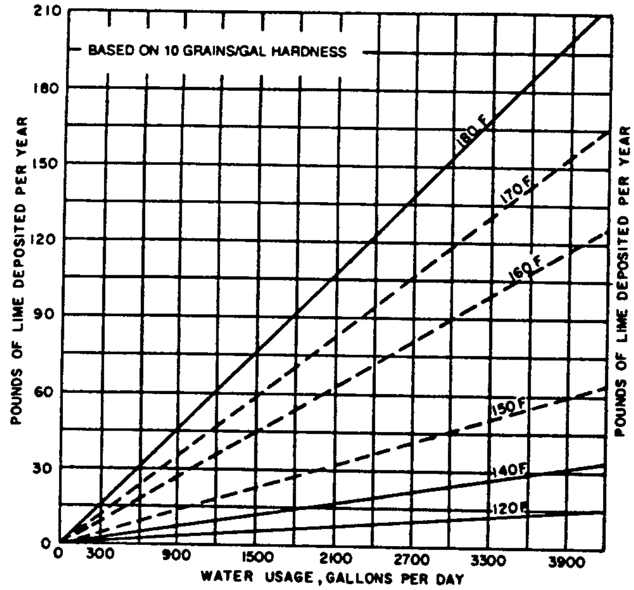

Fig. 8 Lime Deposited Versus Temperature and Water Use
(Purdue University Bulletin No. 74)

enhances electrochemical reactions such as rusting (Toaborek *et al.* 1972). A deposit of scale provides some protection from corrosion; however, this deposit also reduces the heat transfer rate, and it is not under the control of the system designer. Water heaters and hot water storage tanks constructed of stainless steel, copper, or other nonferrous alloys, provide corrosion protection. Some stainless steels, however, may be adversely affected by chlorides, while copper may be attacked by ammonia or carbon dioxide. Steel vessels can be protected to varying degrees by galvanizing or by lining them with copper, glass, cement, or other corrosion-resistant material. Glass-lined vessels are almost always supplied with electrochemical protection. Typically, a rod of magnesium alloy (the anode) is installed in the vessel by the manufacturer. This electrochemically active material sacrifices itself to reduce or prevent corrosion of the tank (the cathode). Higher temperatures, softened wáters, and high water usage may lead to rapid anode consumption. Manufacturers recommend periodic replacement to prolong the life of the vessel. Conversely, some waters have very little electrochemical activity. In this instance, a standard anode will show little or no activity, and the vessel will not be adequately protected. If this condition is suspected, consult the equipment manufacturer on the possible need of a high potential anode.

SAFETY DEVICES FOR HOT WATER SUPPLY SYSTEMS

Various regulatory agencies differ as to the selection of protective devices and methods of installation. As a result, it is essential to check and comply with the manufacturer's instructions and the applicable local codes. In the absence of such instructions and codes, the following recommendations may be used as a guide.

- Thermal expansion control devices limit the pressure that results when the water in the tank is heated and expands in a closed system. While the water-heating system is under service pressure, the pressure will rise rapidly if backflow cannot occur during heating. Backflow can be prevented by devices such as a check valve, pressure-reducing valve, or backflow preventer in the cold waterline or by temporarily shutting off the cold water.

In these cases, the pressure rise may rupture the tank or cause other damage. Such systems must be protected by a properly sized and located diaphragm-type expansion tank.

- Temperature limiting devices (energy cutoff/high limit) prevent water temperatures from exceeding 210°F by stopping the flow of fuel or energy. These devices should be listed and labeled by Underwriter's Laboratories, the American Gas Association (AGA), or other recognized certifying agencies.
- Temperature and pressure relief valves open to prevent water temperature from exceeding 210°F or when the pressure exceeds the valve setting. Combination temperature and pressure relief valves should be AGA or National Board listed and labeled and have a water discharge capacity equal to or exceeding the heat input rating of the water heater. Combination temperature and pressure relief valves should be installed so that the temperature-sensitive element is located in the top 6 in. of the tank, *i.e.*, where the water is hottest.
- Pressure relief valve opens when the pressure exceeds the valve setting. This valve should have a discharge capacity sufficient to relieve excess fluid pressure in the water heater. It should comply with current applicable American National Standards or the ASME Boiler and Pressure Vessel Code.

A pressure relief valve should be installed in any part of the system containing any heat input device that can be isolated by valves. The heat input device may be solar water-heating panels, desuperheater water heaters, heat recovery devices, or similar equipment.

SPECIAL CONCERNS

Legionella pneumophila (Legionnaire's Disease)

The bacteria causing Legionnaire's disease when inhaled has been discovered in the service water systems of various buildings in the United States and abroad. Infection has often been traced to *Legionella pneumophila* colonies in shower heads. Ciesielki *et al.* (1984) determined that the *Legionella pneumophila* can colonize in hot water systems maintained at 115°F or lower. Unrecirculated segments of the service water systems provide ideal breeding locations, *e.g.*, shower heads, faucet aerators, and uncirculated sections of storage-type water heaters.

To limit the potential of *Legionella pneumophila* growth, service water temperatures in the 140°F range are recommended. This high temperature, however, increases the potential for scalding, so care must be taken. Supervised periodic flushing of fixture heads with 170°F water is recommended in hospitals and health care facilities, since already weakened patients are generally more susceptible to infection.

Temperature Requirements

Typical temperature requirements for some services are shown in Table 3. In some cases, slightly lower temperatures may be satisfactory. Temperatures below 140°F are usually obtained by blending hot and cold water at point of use.

Hot Water from Tanks and Storage Systems

With storage systems, 60 to 80% of the hot water in a tank is assumed to be usable before dilution by cold water lowers the temperature below an acceptable level. Thus, the hot water available from a self-contained storage heater is usually considered to be:

$$Q_t = R + MS_t/d \tag{3}$$

where

Q_t = available hot water, gph
R = recovery rate at the required temperature, gph
M = ratio of usable water to storage tank capacity
S_t = storage capacity of the heater tank, gal
d = duration of peak hot water demand, h

Usable hot water from an unfired tank in gallons is calculated from:

$$Q_a = MS_a \tag{4}$$

- Changing electric booster heaters to gas not feasible for the following reasons;

  1. Electricity relatively inexpensive.
  2. Consumption low due to operating hours.
  3. Expensive to route gas to heater, install flue and provide combustion air make-up.

C. Addition of Instantaneous Water Heater

- Instantaneous heaters are best used for steady state, continuous supply. Most facilities have variable flow conditions which causes fluctuations in the supply temperature. These fluctuations could lead to a supply temperature considerably below 180°F, thereby jeopardizing the sanitation process. Also, instantaneous heaters are best when hot water source is far from use. Not recommended.

III. HEAT RECOVERY

A. Heat Recovery from Dishwashers

- Not recommended for following reasons:

  1. High fouling due to waste products in water.
  2. Economy of scale (not feasible).
  3. Only effective during winter and during operation of equipment.
  4. Cost of installation cannot be justified with savings and added maintenance problems.

B. Heat Reclaim from Kitchen Exhaust

- Not recommended for following reasons:

  1. Grease build-up on reclaim coil.
  2. Violates mechanical codes for kitchen hoods.
  3. Creates a fire hazard.

C. Waste Heat Recovery

- Not recommended for following reasons:

  1. No large sources of waste heat.
  2. Few air cooled chillers and refrigeration equipment.
  3. Would result in an increase in maintenance costs.
  4. Cost of installation cannot be justified with energy savings.

AIR-TO-AIR ENERGY RECOVERY

AIR-TO-AIR energy recovery systems may be categorized according to their application as (1) process-to-process, (2) process-to-comfort, and (3) comfort-to-comfort. Typical air-to-air energy recovery applications are listed in Table 1.

Table 1 Applications for Air-to-Air Energy Recovery

Method	Typical Application
Process-to-process and Process-to-comfort	Driers, Ovens, Flue stacks, Burners, Furnaces, Incinerators, Paint exhaust
Comfort-to-comfort	Welding, Swimming pools, Locker rooms, Residential, Smoking exhaust, Operating rooms, Nursing homes, Animal ventilation, Plant ventilation, General exhaust

APPLICATIONS

Process-to-Process

In process-to-process applications, heat is captured from the process exhaust stream and transferred to the process supply airstream. Equipment is available to handle process exhaust temperatures as high as 1600°F.

Process-to-process recovery devices generally recover only sensible heat and do not transfer latent heat (humidity), as moisture transfer is usually detrimental to the process. Process-to-process applications usually recover the maximum amount of energy. In cases involving condensables, less recovery may be desired to prevent condensation and possible corrosion.

Process-to-Comfort

In process-to-comfort applications, waste heat captured from a process exhaust heats the building makeup air during winter. Typical applications include foundries, strip coating plants, can plants, plating operations, pulp and paper plants, and other processing areas with heated process exhaust and large makeup air volume requirements.

Although full recovery is desired in process-to-process applications, recovery for process-to-comfort applications must be modulated during warm weather to prevent overheating the makeup air. During summer, no recovery is required. Because energy is saved only in the winter and recovery is modulated during moderate weather, process-to-comfort applications save less energy over a year than do process-to-process applications.

Process-to-comfort recovery devices generally recover sensible heat only and do not transfer moisture between the airstreams.

Comfort-to-Comfort

In comfort-to-comfort applications, the heat recovery device lowers the enthalpy of the building supply air during warm weather and raises it during cold weather by transferring energy between the ventilation air supply and the exhaust airstreams.

In addition to commercial and industrial energy recovery equipment, small-scale packaged ventilators with built-in heat recovery components known as heat recovery ventilators (HRV) are available for residential and small-scale commercial applications.

Air-to-air energy recovery devices available for comfort-to-comfort applications may be sensible heat devices (*i.e.*, transferring sensible energy only) or total heat devices (*i.e.*, transferring both sensible energy and moisture). These devices are discussed further in the section Technical Considerations.

ECONOMIC CONSIDERATIONS

An analysis of energy recovery should consider the application over its lifetime. Neither the most efficient nor the least expensive energy recovery device may be the most economical. Many manufacturers and suppliers have computer programs to provide application-specific design and cost benefit information. Chapter 33 of the 1991 ASHRAE *Handbook—HVAC Applications* describes methods for making detailed cost/benefit analyses.

Energy costs. The absolute cost of energy and the relative costs of various energy forms are major economic factors. High energy costs favor high levels of energy recovery. In regions where electrical costs are high relative to fuel prices, heat recovery devices with low pressure drops are preferable.

Other conservation options. Energy recovery should be evaluated against other cost-saving opportunities, including reducing or eliminating the primary source of waste energy through process modification.

Amount of useable waste energy. Economies of scale favor large installations, although equipment is commercially available for air-to-air energy recovery applications from 50 cfm and more. Although using equipment with higher effectiveness results in more recovered energy, equipment costs and space requirements also increase with effectiveness.

Grade of waste energy. High-grade (*i.e.*, high-temperature) waste energy is generally more economical to recover than low-grade energy. Large temperature differences between the waste energy source and destination are most economical.

The preparation of this chapter is assigned to TC 5.5, Air-to-Air Energy Recovery.

Coincidence and duration of waste heat supply and demand. Energy recovery is most economical when the supply is coincident with the demand and both are relatively constant throughout the year. Thermal storage may be used to store energy if supply and demand are not coincident, but this adds cost and complexity to the system.

Proximity of supply to demand. Applications with a large central energy source and a nearby waste energy use are more favorable than applications with several scattered waste energy sources and uses.

Operating environment. High operating temperatures or the presence of corrosives, condensables, and particulates in either airstream result in higher equipment and maintenance costs. Increased equipment costs result from the use of corrosion- or temperature-resistant materials, and maintenance costs are incurred by an increase in the frequency of equipment repair and washdown and additional air filtration requirements.

Effects on pollution control systems. Removing process heat may reduce the cost of pollution control systems by allowing less expensive filter bags to be used, by improving the efficiency of electronic precipitators, or by condensing out contaminant vapors, thus reducing the load on downstream pollution control systems. In some applications, recovered condensables may be returned to the process for reuse.

Effects on heating and cooling equipment. Heat recovery equipment may reduce the size requirements for primary utility equipment such as boilers, chillers, and burners, and the size of piping and electrical services to them. Larger fans and fan motors (and hence fan energy) are generally required to overcome increased static pressure losses caused by the energy recovery devices. Auxiliary heaters may be required for frost control.

Effects on humidifying or dehumidifying equipment. Selecting total energy recovery equipment results in the transfer of moisture from the airstream with the greater humidity ratio to the airstream with the lesser humidity ratio. In many situations this is desirable, since humidification costs are reduced in cold weather and dehumidification loads are reduced in warm weather (ASHRAE 1988).

TECHNICAL CONSIDERATIONS

Performance Rating

ASHRAE *Standard* 84-91, Method of Testing Air-to-Air Heat Exchangers, establishes rating and testing proceedures for commercial air-to-air heat recovery equipment. CAN/CSA-439-88, Standard Methods of Test for Rating the Performance of Heat Recovery Ventilators (HRV), is used to rate small (under 200 L/s) packaged ventilators with heat recovery.

The effectiveness of air-to-air heat exchangers is commonly measured in terms of:

- Sensible energy transfer (dry-bulb temperature)
- Latent energy transfer (humidity ratio)
- Total energy transfer (enthalpy)

ASHRAE *Standard* 84 defines effectiveness as:

$$\epsilon = \frac{\text{Actual transfer (of energy or moisture)}}{\text{Maximum possible transfer between airstreams}}$$

Referring to Figure 1,

$$\epsilon = \frac{W_s(X_1 - X_2)}{W_{min}(X_1 - X_3)} = \frac{W_e(X_4 - X_3)}{W_{min}(X_1 - X_3)} \tag{1}$$

where

ϵ = sensible, latent, or total effectiveness
X = dry-bulb temperature, humidity ratio, or enthalpy (at the location indicated in Figure 1), respectively, and

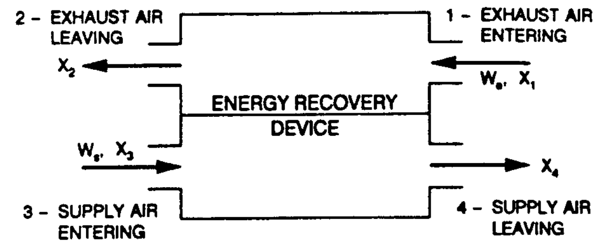

Fig. 1 Airstream Numbering Convention

W_{min} = the smaller of W_s and W_e where,

For latent and total effectiveness:
W_s = supply air mass flow
W_e = exhaust air mass flow

For sensible effectiveness:
W_s = (specific heat) × (supply air mass flow rate)
W_e = (specific heat) × (exhaust air mass flow rate)

The leaving supply air condition is:

$$X_2 = X_1 - \epsilon(W_{min}/W_s)(X_1 - X_3) \tag{2}$$

and the leaving exhaust air condition is:

$$X_4 = X_3 + \epsilon(W_{min}/W_e)(X_1 - X_3) \tag{3}$$

Equations (1), (2), and (3) assume that no heat transfers between the heat exchanger and its surroundings, nor are there gains from cross leakage, fans, or frost control devices. This assumption is generally true for larger commercial applications but not for HRVs. The rating term used in CAN/CSA-439-88 for HRVs is defined as the energy recovery efficiency (*i.e.*, the actual energy transfer efficiency) and the apparent sensible effectiveness (*i.e.*, a measure of the temperature rise of the supply airstream, including that resulting from external gains).

A number of variables can affect these performance factors, whether the device is designed to transfer total energy or just sensible heat. These variables include (1) humidity ratio of the warmer airstream, (2) heat transfer area, (3) air velocities through the heat exchangers, (4) airflow arrangement, (5) supply and exhaust air mass flow rates, and (6) method of frost control. The effect of some of these are shown in Figures 2, 3, and 4. The impacts of frost control method on seasonal performance are discussed in Phillips *et al.* (1989a), and sensible versus latent heat recovery for residential comfort-to-comfort applications is addressed in Barringer and McGugan (1989b).

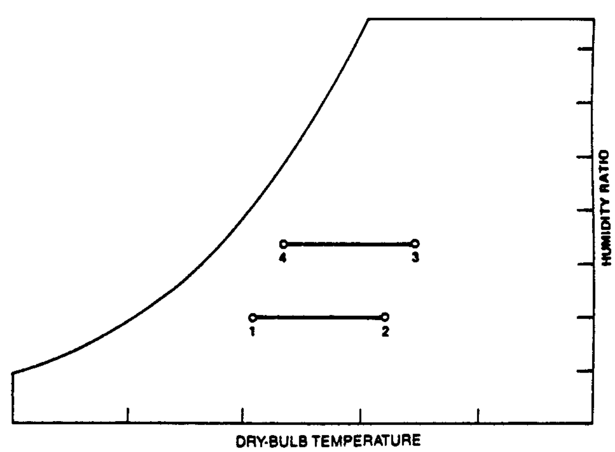

Fig. 2 Sensible Heat Recovery

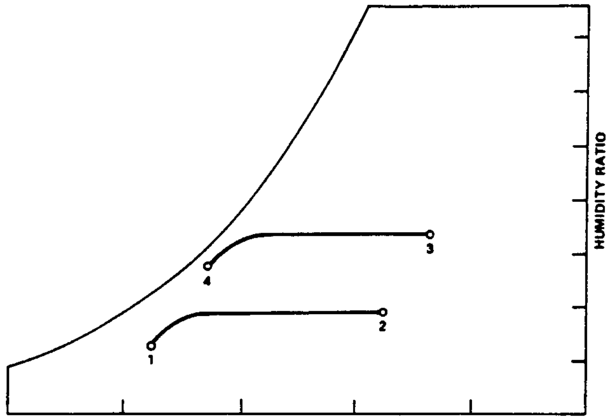

Fig. 3 Sensible Rotary Heat Exchanger Recovering Latent Heat

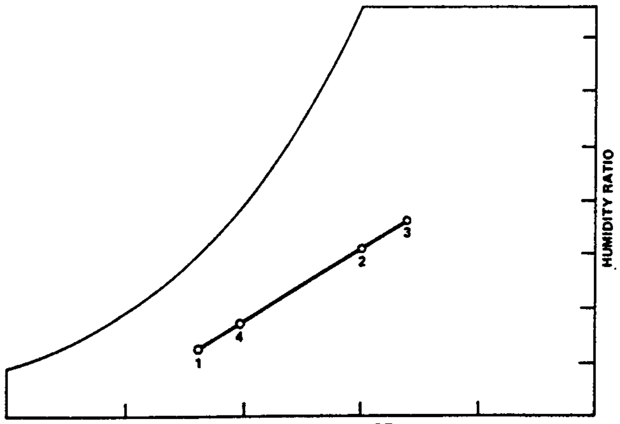

Fig. 4 Total Heat Recovery

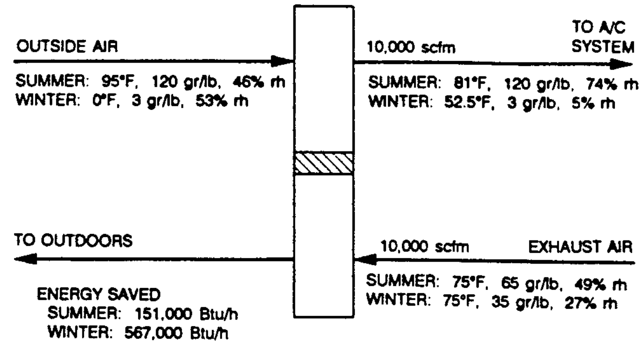

Fig. 5 Comfort-to-Comfort Sensible Heat Device

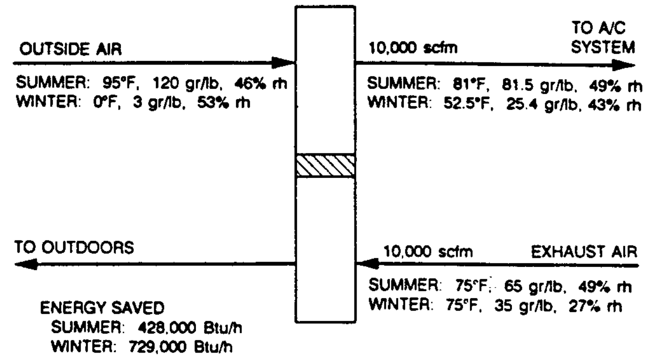

Fig. 6 Comfort-to-Comfort Total Heat Device

Sensible versus Total Recovery

Air-to-air energy recovery devices are available for sensible heat recovery and total heat recovery.

Since sensible heat devices do not transfer moisture, no latent heat is exchanged between supply and exhaust airstreams, except where the exhaust airstream is cooled below its dew point. When condensation occurs, some latent heat is transferred.

Total heat devices transfer both sensible heat and latent heat (humidity) between supply and exhaust airstreams. Unlike process-to-process and process-to-comfort applications, latent transfer is frequently desired in comfort-to-comfort applications.

A typical sensible heat recovery process between supply and exhaust airstreams is shown in Figure 2. Cold air is heated from 1 to 2, while hot air is cooled from 3 to 4. In this case, the cold air temperature is above the dew point of the hot air, and no condensation takes place.

Figure 3 illustrates a sensible heat recovery process in which condensation occurs in the hot airstream, along with evaporation in the cold one. Here latent heat transfer enhances overall effectiveness.

Figure 4 illustrates a total heat recovery process when mass flow rates and the latent and total heat effectiveness are equal. For this case, outlet states 2 and 4 lie on the straight line through cold-air inlet state 1 and hot-air inlet state 3.

Figure 5 shows a comfort-to-comfort application of a device with 70% effectiveness of sensible heat only; Figure 6 shows a device of 70% effectiveness of both sensible heat and latent heat operating under the same conditions. Under typical summer design conditions, the total heat device transfers nearly three times as much energy as the sensible heat device. Under typical winter design conditions, the total heat device recovers more than 25% more energy than the sensible heat device. Figure 7 shows the processes and a comparison of the energy transfers for these example systems for both summer and winter conditions on a psychrometric chart.

Fouling

The term fouling refers to an accumulation of dust or condensates on heat exchanger surfaces. Increasing the resistance to airflow and generally decreasing heat transfer coefficients, fouling reduces heat exchanger performance. The increased resistance increases fan power requirements and may reduce airflows.

Pressure drop across the heat exchanger core can be used as an indication of fouling and, with experience, may be used to establish cleaning schedules. Heat exchanger surfaces must be kept clean if system performance is to be maximized.

Corrosion

Process exhaust frequently contains substances requiring corrosion-resistant construction materials. If it is not known which materials are most corrosion-resistant for an application, the user and/or designer should examine on-site ductwork, review literature, and contact equipment suppliers prior to selecting materials. A corrosion study of heat exchanger construction materials in the proposed operating environment may be warranted if the installation costs are high and the environment is corrosive. Experimental procedures for such studies are described in an ASHRAE symposium (1982). Often contaminants not directly related to the process are present in the exhaust airstream (*e.g.*, welding fumes or paint carryover from adjacent processes).

Moderate corrosion generally occurs over time, roughening metal surfaces and increasing their heat transfer coefficients. Severe corrosion reduces overall heat transfer and can result in

Random flow media, consisting of knitted corrugated mesh, are made by knitting wire into an open woven cloth, which is layered to the desired configuration. Aluminum mesh, commonly used for comfort ventilation systems, is packed in pie-shaped wheel segments. Stainless steel and monel mesh are used for high-temperature and corrosive applications. These media should only be used with clean, filtered airstreams because they plug easily.

Directionally oriented media consist of small (0.0625 in.) triangular air passages parallel with the direction of airflow. The triangular shape gives the largest exposed surface for air contact per unit of face area; it is also strong and is easily produced by interleaving layers of flat and corrugated material. Aluminum foil, inorganic sheet, treated organic sheet, and synthetic materials are used for low and medium temperatures. Stainless steel and ceramics are used for high temperatures and corrosive atmospheres.

Media surface areas exposed to airflow vary from 100 to 1000 ft^2/ft^3, depending on the type of medium and physical configuration. Media may also be classified according to their ability to recover only sensible heat or total heat. Media for sensible heat recovery are made of aluminum, copper, stainless steel, and monel. Media for total heat recovery are fabricated from any of a number of materials and treated with a desiccant, typically lithium chloride or alumina, to have specific moisture recovery characteristics.

Cross-Contamination

Cross-contamination, or mixing, of air between supply and exhaust airstreams occurs in all rotation energy exchangers by two mechanisms—carryover and leakage. Carryover occurs as air is entrained within the volume of the rotation medium and is carried into the other airstream. Leakage occurs because the differential static pressure across the two airstreams drives air from a higher to a lower static pressure region. Leakage can be reduced by placing the blowers so that they promote leakage of outside air to the exhaust airstream. Carryover occurs each time a portion of the matrix passes the seals dividing the supply and exhaust airstreams. Since carryover from exhaust to supply may be undesirable, a purge section can be installed on the heat exchanger to prevent cross-contamination.

In many applications, recirculating some air is not a concern. However, critical applications, such as hospital operating rooms, laboratories, and clean rooms, require stringent control of carryover. Carryover can be reduced to below 0.1% of the exhaust airflow with a purge section (ASHRAE 1974).

The theoretical carryover of a wheel without a purge is directly proportional to the speed of the wheel and the void volume of the media (75 to 95% void, depending on type and configuration). For example, a 10-ft diameter, 8-in. deep wheel, with a 90% void volume operating at 14 rpm, has a carryover volume of:

$$(10)^2(\pi/4)(8/12)(0.9)(14) = 660 \text{ cfm}$$

If the wheel is handling a 20,000 cfm balanced flow, the percentage carryover is:

$$(660/20{,}000)(100) = 3.3\%$$

The exhaust fan, which is usually located at the exit of the exchanger, should be sized to include leakage, purge, and carryover airflows.

Controls

Two control methods are commonly used to regulate wheel energy recovery. In the first, supply air bypass control, the amount of supply air allowed to pass through the wheel establishes the supply air temperature. An air bypass damper, controlled by a wheel supply air discharge temperature sensor, regulates the proportion of supply air permitted to bypass the exchanger.

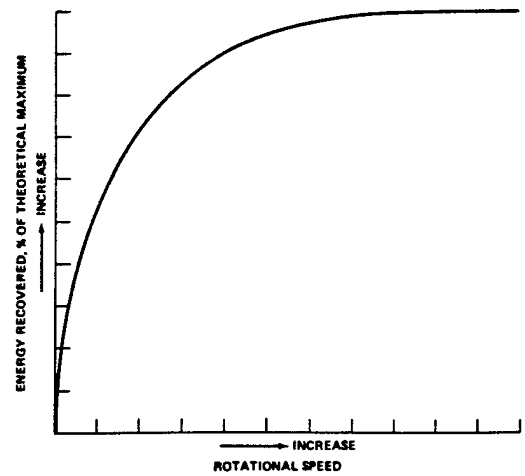

Fig. 15 Typical Wheel Energy Recovery Capacity versus Rotational Speed

The second method regulates the energy recovery rate by varying wheel rotational speed (Figure 15). The most frequently used variable-speed drives are (1) a silicon controlled rectifier (SCR) with variable speed dc motor, (2) a constant speed ac motor with hysteresis coupling, and (3) an ac frequency inverter with an ac induction motor.

A dead band control, which stops or limits the exchanger, may be necessary when no recovery is desired (*e.g.*, when outside air temperature is higher than the required supply air temperature but below the exhaust air temperature). When the outside air temperature is above the exhaust air temperature, the equipment operates at full capacity to cool the incoming air.

Maintenance

Energy exchanger wheels require little maintenance. The following maintenance procedures ensure best performance:

- Clean the medium when lint, dust, or other foreign materials build up, following the manufacturer's instructions for that medium type. Media treated with a liquid desiccant for total heat recovery must not be wetted.
- Maintain drive motor and train according to the manufacturer's recommendations. Speed control motors that have commutators and brushes require more frequent inspection and maintenance than do induction motors. Brushes should be replaced, and the commutator should be periodically turned and undercut.
- Inspect wheels regularly for proper belt or chain tension.
- Refer to the manufacturer's recommendations for spare and replacement parts.

COIL ENERGY RECOVERY (RUNAROUND) LOOPS

A typical coil energy recovery loop system (Figure 16) places extended surface, finned tube water coils in the supply and exhaust airstreams of a building or process. The coils are connected in a closed loop via counterflow piping through which an intermediate heat transfer fluid (typically water or a freeze-preventive solution) is pumped.

This system operates for sensible heat recovery only. In comfort-to-comfort applications, energy transfer is seasonally reversible—the supply air is preheated when the outdoor air is cooler than the exhaust air and precooled when the outdoor air is warmer.

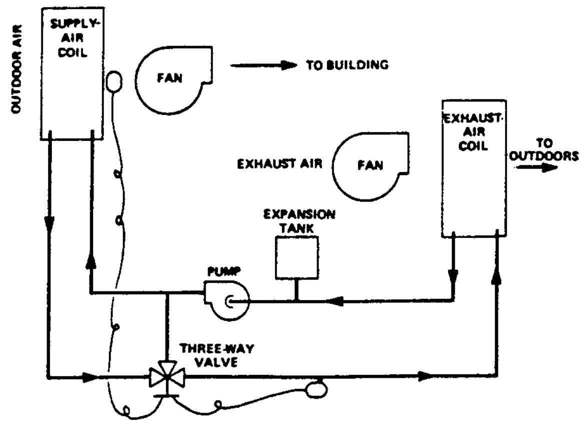

Fig. 16 Coil Energy Recovery Loop

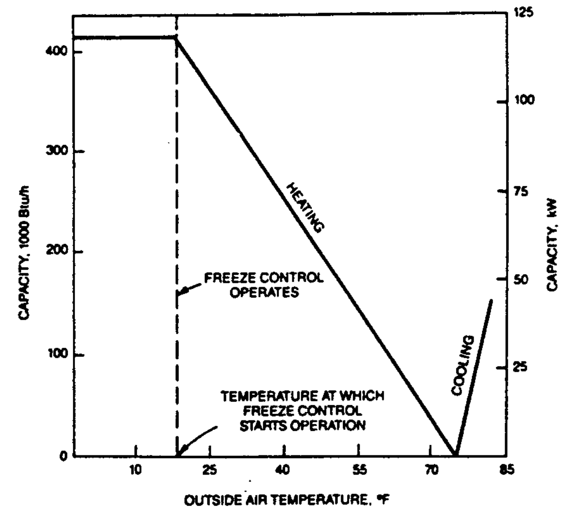

Fig. 17 Energy Recovery Capacity versus Outside Air Temperature for Typical Loop

Freeze Protection

Moisture must not freeze in the exhaust coil air passage. A dual-purpose, three-way temperature control valve prevents the exhaust coil from freezing. The valve is controlled to maintain the entering solution temperature to the exhaust coil to not less than 30 °F. This condition is maintained by bypassing some of the warmer solution around the supply air coil. The valve can also ensure that a prescribed air temperature from the supply air coil is not exceeded.

System Characteristics

Coil energy recovery loop systems are highly flexible and well-suited to renovation and industrial applications. The system accommodates remote supply and exhaust ducts and allows the simultaneous transfer of energy between multiple sources and uses. An expansion tank must be included to allow fluid expansion and contraction. A closed expansion tank minimizes oxidation when ethylene glycol is used.

Standard finned tube water coils may be used. Manufacturer's design curves and performance data should be used when selecting coils, face velocities, and pressure drops.

Effectiveness

The coil energy recovery loop cannot transfer moisture from one airstream to another. For the most cost-effective operation, with equal airflow rates and no condensation, typical effectiveness values range from 60 to 65%. Highest effectiveness does not necessarily give the greatest net cost savings.

The following example illustrates the capacity of a typical system:

Example 1. A waste heat recovery system heats 10,000 cfm of air from a 0 °F design outdoor temperature to an exhaust dry-bulb temperature of 75 °F and a wet-bulb temperature of 60 °F. The air flows through identical eight-row coils at a 400 fpm face velocity. A 30% ethylene glycol solution flows through the coils at 26 gpm.

Figure 17 shows the effect of the outside air temperature on capacity, including the effects of the three-way temperature control valve. For this example, the capacity is constant for outside air temperatures below 18.5 °F. This constant output occurs because the valve has to control the temperature of the fluid entering the exhaust coil to prevent frosting. As the exhaust coil is the source of heat and has a constant airflow rate, entering air temperature, liquid flow rate, entering fluid temperature (as set by the valve), and fixed coil parameters, energy recovered must be fixed to prevent frosting. Equation (1) may be used to calculate the sensible heat effectiveness.

When the three-way control valve operates at outside air temperatures of 18.5 °F or lower, 414,000 Btu/h is recovered. At 18.5 °F, the sensible heat effectiveness is 67.2%. At the 0 °F design temperature sensible effectiveness is 51% (ϵ = 414,000/810,000), and the leaving air dry-bulb temperature of the supply coil is 38.3 °F. Above 75 °F outside air temperature, the system begins to cool the supply air.

Typically, the sensible heat effectiveness of a coil energy recovery loop is independent of the outside air temperature. However, when the capacity is controlled (as in the preceding example) the sensible heat effectiveness decreases.

Construction Materials

Coil energy recovery loops incorporate coils constructed to suit the environment and operating conditions to which they are exposed. For typical comfort-to-comfort applications, standard coil construction usually suffices. In process-to-process and process-to-comfort applications, the effect of high temperature, condensables, corrosives, and contaminants on the coil(s) must be considered.

At temperatures, above 400 °F, special construction may be required to ensure a permanent fin-to-tube bond. The effects of condensables and other adverse factors may require special coil construction and/or coatings. Chapters 21, and 24 discuss the construction and selection of coils in more detail.

Cross-Contamination

Complete separation of the airstreams eliminates cross-contamination between the supply and exhaust air.

Maintenance

Coil energy recovery loops require little maintenance. The only moving parts are the circulation pump and the three-way control valve. However, the following items must be maintained to ensure optimum operation: air filtration; cleaning of the coil surface; periodic maintenance of the pump and valve; and transfer fluid. Fluid manufacturers or their representatives should be contacted for specific recommendations.

Thermal Transfer Fluids

The thermal transfer fluid used in a closed-loop application depends on the application and temperatures of the two airstreams.

An inhibited ethylene glycol solution in water is commonly used when freeze protection is required. These solutions break down to an acidic sludge if temperatures exceed 275 °F. If freeze protection is needed and exhaust air temperatures exceed 275 °F, a nonaqueous synthetic heat transfer fluid should be used. Heat transfer fluid manufacturers and chemical suppliers should recommend appropriate fluids.

IV. HVAC

B. Economizer Controls

- ASHRAE recommends against this ECO due to high humidity (see following ASHRAE Standard 90A, paragraph 5.6 and Weather Data).

THIS PUBLICATION INCLUDES THE FOLLOWING SECTIONS:

(1) ANSI/ASHRAE/IES 90A-1980 (SUPERSEDES SECTIONS 1-9 OF ASHRAE/IES STANDARD 90-75)

(2) ASHRAE/IES 90B-1975 (SECTIONS 10 AND 11 OF ASHRAE/IES STANDARD 90-75)

(3) ASHRAE 90C-1977 (SECTION 12 AS PUBLISHED FEBRUARY 16, 1977)

CLARIFICATION OF THE STATUS OF EACH SECTION IS INCLUDED IN THE FOREWORD.

ASHRAE STANDARD

ENERGY CONSERVATION IN NEW BUILDING DESIGN

ASHRAE Standards are updated on a five-year cycle; the date following the Standard number is the year of approval. The latest copies may be purchased from the ASHRAE Publication Sales Department, 1791 Tullie Circle, NE, Atlanta, GA 30329
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provide a readily accessible, manual or automatic means for reducing the energy required for heating and cooling during periods of non-use or reduced need such as but not limited to unoccupied periods and sleeping hours. Lowering thermostat set points to reduce energy consumption of heating systems shall not cause energy to be expended to reach the reduced setting.

5.4.4.2 Other Buildings and Occupancies. Each system shall be equipped with a readily accessible means of shutting off or reducing the energy used during periods of non-use or alternate uses of the building spaces or zones served by the system. The following are examples that meet this requirement:

a. Manually adjustable automatic timing devices
b. Manual devices for use by operating personnel
c. Automatic control systems

5.5 Simultaneous Heating and Cooling

The use of both heating and cooling simultaneously in order to achieve comfort conditions within a space is inefficient energy utilization. This use shall be limited to those situations where more efficient methods of heating and air conditioning cannot be effectively utilized to meet system objectives. Separate systems should be considered to serve areas of building with substantially different heating/cooling load characteristics (for example, the perimeter space as compared to the interior space). Simultaneous heating and cooling by reheating or recooling supply air or by concurrent operation of independent heating and cooling systems serving a common zone shall be restricted as delineated below.

5.5.1 Recovered energy in excess of the new energy expended in the recovery process may be used for control of temperature and humidity. New energy is defined as energy, other than recovered, utilized for the purpose of heating or cooling.

5.5.2 New energy may be used, when necessary, to prevent relative humidity from rising above 60 percent for comfort control or to prevent condensation on terminal units or outlets.

5.5.3 New energy may be used for control of temperature if minimized as delineated in 5.5.4 through 5.5.8.

5.5.4 Reheat Systems. Systems employing reheat and serving multiple zones, other than those employing variable air volume for temperature control, shall be provided with control that will automatically reset the system cold air supply to the highest temperature level that will satisfy the zone requiring the coolest air. Single zone reheat systems shall be controlled to sequence reheat and cooling.

5.5.5 Dual Duct and Multi-Zone Systems. These systems, other than those employing variable air volume for temperature control, shall be provided with control that will automatically reset (a) the cold deck air supply to the highest temperature that will satisfy the zone requiring the coolest air and (b) the hot deck air supply to the lowest temperature that will satisfy the zone requiring the warmest air.

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5.5.6 Recooling Systems. Systems in which heated air is recooled, directly or indirectly, to maintain space temperature shall be provided with control that will automatically reset the temperature to which the supply air is heated to the lowest level that will satisfy the zone requiring the warmest air.

5.5.7 For systems with multiple zones, one or more zones may be chosen to represent a number of zones with similar heating/cooling characteristics. A multiple zone system which employs reheating or recooling for control of not more than 2.36 m^3/s (5,000 ft^3/min) or 20 percent of the total supply air of the system, whichever is less, shall be exempt from the supply air temperature reset requirement of 5.5.4 through 5.5.6.

5.5.8 Concurrent operation of independent heating and cooling systems serving common spaces and requiring the use of new energy for heating or cooling shall be minimized by one or both of the following:

a. By providing sequential temperature control of both heating and cooling capacity in each zone.

b. By limiting the heating energy input through automatic reset control of the heating medium temperature (or energy input rate) to only that necessary to offset heat loss due to transmission and infiltration and, where applicable, to heat the ventilation air supply to the space.

5.6 Cooling with Outdoor Air (Economizer Cycle)

Each fan system shall be designed to use up to and including 100 percent of the fan system capacity for cooling with outdoor air automatically. Activation of economizer cycle shall be controlled by sensing outdoor air enthalpy and dry-bulb temperature jointly or outdoor air dry-bulb temperature jointly or outdoor air dry-bulb temperature alone to accomplish the above.

Exceptions. Cooling with outdoor air is not required under any one or more of the following conditions:

a. The fan system capacity is less than 2.36 m^3/s (5,000 ft^3/min) or total cooling capacity less than 39.3 kW (134,000 Btu/h).

b. The quality of the outdoor air (as defined in Table 1 of ANSI/ASHRAE Standard 62-73[8]) is so poor as to require extensive treatment of the air.

c. The need for humidification and/or dehumidification requires the use of more energy than is conserved by outdoor air cooling on an annual basis.

d. The use of outdoor air cooling may affect the operation of other systems (such as return or exhaust air fans or supermarket refrigeration) so as to increase the overall energy consumption of the building.

e. When energy recovered from an internal/external zone heat recovery system exceeds the energy conserved by outdoor air cooling on an annual basis.

f. The Annual Celsius Heating Degree Days are less than 670 (1,200 Fahrenheit Degree Days).

g. Outdoor Wet Bulb Design Conditions of more than 22°C (72F) and Annual Celsius Heating Degree Days are less than 1110 (2000 Fahrenheit Degree Days).

h. When space cooling is accomplished by a circulating liquid which transfers space heat directly or indirectly to a heat rejection device such as a cooling

tower without the use of a refrigeration system.

i. When the use of 100 percent outside air will cause coil frosting, controls may be added to reduce the quantity of outside air. However, the intent of this exception is to use 100 percent air in lieu of mechanical cooling when less energy usage will result, and this exception applies only to direct expansion systems when the compressor(s) is running.

j. When the fan system will regularly be operated for less than 30 hours per week.

k. When the total design sensible cooling load is less than 21.6 W/m^2 ($2W/ft^2$) (6.8 $Btu/h \cdot ft^2$) of floor area.

l. For single family and multi-family residential buildings.

5.7 Mechanical Ventilation

Each mechanical ventilation system (supply and/or exhaust) shall be equipped with a readily accessible switch or other means for shutoff or volume reduction and shut off when ventilation is not required. Automatic or gravity dampers that close when the system is not operating shall be provided for outdoor air inakes and exhausts. There is no standard at this time for damper leakage. Automatic or manual dampers installed for the purpose of shutting off outside air intakes and exhausts for ventilation systems shall be designed with tight shutoff characteristics to minimize air leakage.

Exceptions.

1. Manual dampers for outdoor air intakes may be used in the following cases:
   a. For single and multi-family residential buildings.
   b. When the fan system capacity is less than 2.36 m^3/s (5000 ft^3/min).
2. Dampers are not required when ventilation airflow is less than 0.047 m^3/s (100 ft^3/min).

5.8 Transport Energy

5.8.1 All Air Systems. The air transport factor for each all-air system shall not be less than 5.5. The factor shall be based on design system air flow for constant volume systems. The factor for variable air volume systems may be based on average conditions of operation. Energy for transfer of air through heat recovery devices shall not be included in determining the factor; however, such energy shall be included in the evaluation of the effectiveness of the heat recovery system.

$$\text{Air Transport Factor} = \frac{\text{Space Sensible Heat Removal*}}{\text{(Supply + Return Fan(s) Power Input)*}}$$

*Both expressed in either watts or Btu/h

For purposes of these calculations, Space Sensible Heat Removal is equivalent to the maximum coincident design sensible cooling load of all spaces served for which the system provides cooling. Fan Power Input is the rate of energy delivered to the fan prime mover.

5.8.2 Other Systems. Air and water, all water and unitary systems employing chilled, hot, dual temperature or condensr water transport systems to space terminals shall not require greater transport energy (including central and terminal fan power and pump power) than an equivalent all air system providing the same space sensible heat removal and having an air transport factor not less than 5.5.

5.9 Energy Recovery

It is recommended that consideration be given to the use of recovery systems which will conserve energy (provided the amount expended is less than the amount recovered) when the energy transfer potential and the operating hours are considered.

5.10 Piping Insulation

All piping installed to serve buildings and within buildings shall be thermally insulated in accordance with Table 5.1. (For service water heating systems see Section 7.)

Exceptions. Piping insulation is not required in any of the following cases:

a. Piping installed within HVAC equipment

b. Piping at fluid temperatures between 13°C and 49°C (55 to 120F)

c. When the heat loss and/or heat gain of the piping, without insulation, does not increase the energy requirements of the building

d. Where piping is installed in basements, cellars or unventilated crawl spaces having insulated walls in one- and two-family dwellings.

5.10.1 Other Insulation Thicknesses. Insulation thicknesses in Table 5.1 are based on insulation having thermal resistivity in the range of 0.028 to 0.032 $m^2 \cdot °C/W \cdot mm$ (4.0 to 4.6 $ft^2 \cdot h \cdot F/Btu \cdot in$) on a flat surface at a mean temperature of 24°C (75F). Minimum insulation thickness shall be increased for materials having R values less than 0.028 $m^2 \cdot °C/W \cdot mm$ (4.0 $ft^2 \cdot h \cdot F/Btu \cdot in$) or may be reduced for materials having R values greater than 0.032 $m^2 \cdot °C/W \cdot mm$ (4.6 $ft^2 \cdot h \cdot F/Btu \cdot in$).

a. For materials with thermal resistivity greater than 0.032 $m^2 \cdot °C/W \cdot mm$ (4.6 $ft^2 \cdot h \cdot F/Btu \cdot in$) the minimum insulation thickness may be reduced as follows:

In SI Units:

$$\frac{0.032 \times \text{Table 5.1 Thickness}}{\text{Actual R}} = \text{New Minimum Thickness}$$

In Conventional units:

$$\frac{4.6 \times \text{Table 5.1 Thickness}}{\text{Actual R}} = \text{New Minimum Thickness}$$

b. For materials with thermal resistivity less than 0.028 $m^2 \cdot °C/W \cdot mm$ (4.0 $ft^2 \cdot h \cdot F/Btu \cdot in$), the minimum insulation thickness shall be increased as follows:

In SI Units:

$$\frac{0.028 \times \text{Table 5.1 Thickness}}{\text{Actual R}} = \text{New Minimum Thickness}$$

In Conventional units:

$$\frac{4.0 \times \text{Table 5.1 Thickness}}{\text{Actual R}} = \text{New Minimum Thickness}$$

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- DEPARTMENT OF THE AIR FORCE MANUAL — AFM 88-29
- DEPARTMENT OF THE ARMY TECHNICAL MANUAL — TM 5-785
- DEPARTMENT OF THE NAVY MANUAL — NAVFAC P-89

Facility Design and Planning

ENGINEERING WEATHER DATA

DEPARTMENTS OF THE AIR FORCE, THE ARMY, AND THE NAVY

1 JULY 197

566

TEXAS

Station	Lat N	Long W	Elev	99%	97.5%	Pvlg Wind	Mean Speed	Heating	1%	MCWB	2.5%	MCWB	Mean Daily Range	Pvlg Wind	5%	MCWB	1%	2.5%	5%	≥ 93°F	≥ 80°F	≥ 73°F	≥ 67°F
Abilene MAP	32 25	99 41	1784	15	20	N	12	[illegible]0	101	71	99	71	24	SSE	97	71	75	74	74	433	1922	340	[illegible]
Aero Main[illegible]nce Center	27 46	97 26	40	32	36	N	12	[illegible]	95	78	94	78	17	SSE	92	78	80	80	79	134	2507	3238	3[illegible]
Amarillo	35 14	101 42	3604	6	11	N	11	[illegible]3	98	67	95	67	28	S	93	67	71	70	70	180	1181	9	739
Austin/Rob[illegible]t Mueller MAP	30 18	97 42	597	24	28	N	11	1737	100	74	98	74	23	S	97	74	78	77	77	430	2041	1959	3400
Beaumont/Jefferson Co	29 57	94 01	16	27	31	N	9	1518	95	79	93	78	18	S	91	78	81	80	80	88	1863	2787	3708

STATE Station	LOCATION Lat (° ′ N)	LOCATION Long (° ′ W)	Elev (feet)	WINTER DESIGN DATA HEATING Dry Bulb 99% (°F)	97.5% (°F)	Pvlg Wind (dir)	Mean Speed (knots)	DEGREE DAYS Heating (annual)	SUMMER DESIGN DATA AIR CONDITIONING Dry Bulb 1% (°F)	MCWB (°F)	2.5% (°F)	MCWB (°F)	Mean Daily Range (°F)	Pvlg Wind (dir)	5% (°F)	MCWB (°F)	Wet Bulb 1% (°F)	2.5% (°F)	5% (°F)	SUMMER CRITERIA DATA AIR CONDITIONING Dry Bulb ≥ 93°F (hrs)	≥ 80°F (hrs)	Wet Bulb ≥ 73°F (hrs)	≥ 67°F (hrs)
TEXAS (CONT)																							
Beaumont Army Hospital	31 49	106 28	4185	20	24	N	7	2678	100	64	98	64	25	S	96	64	69	68	68	370	1917	0	376
Beeville/Chase Field NAS	28 22	97 40	190	30	33	N	9	1189	99	78	97	77	21	SSE	95	77	82	81	79	301	2144	2776	3786
Bergstrom AFB/Austin	30 12	97 40	541	24	28	N	10	1712	99	74	97	75	22	S	96	75	79	78	77	363	1966	1844	3384
Brooke Army Medical Center	29 28	98 27	785	25	30	N	8	1570	99	72	97	73	22	SSE	96	73	77	76	76	397	2049	1699	3426
Brooks AFB	29 21	98 27	598	28	32	N	10	1272	100	74	98	74	22	SSE	97	74	78	77	77	460	2189	2185	3551
Brownsville IAP	25 54	97 26	19	35	39	NNW	13	650	94	77	93	77	16	SE	92	77	80	79	79	103	2456	3391	4090
Brownwood	31 48	98 57	1386	18	22	N	9	2437	101	73	99	73	23	S	96	73	77	76	75	297	1922	1045	3043
Camp Bullis	29 41	98 45	1400	23	28	N	8	1952	100	74	97	74	23	S	94	74	78	77	76	220	1626	1481	3348
Carswell AFB/Fort Worth	32 47	97 26	650	18	23	N	10	2301	101	75	99	75	22	S	97	74	78	77	76	415	1969	1182	2928
Corpus Christi IAP	27 46	97 30	41	31	35	N	12	930	95	78	94	78	17	SSE	92	78	80	80	79	134	2507	3238	3989
Corpus Christi NAS	27 42	97 17	19	34	38	N	12	899	92	79	91	79	12	SE	90	79	82	81	80	15	2845	3329	4036
Dallas/Love Field	32 51	96 51	481	18	22	N	11	2290	102	75	100	75	21	S	97	75	78	78	77	474	2208	1675	3103
Dallas NAS/Hensley Field	32 44	96 58	495	20	25	NNW	9	2308	102	76	100	76	22	S	98	76	79	78	77	497	2229	1764	3092
Del Rio IAP	29 22	100 55	1026	26	31	NNW	9	1523	100	73	98	73	23	SE	97	73	79	77	76	509	2349	1260	3367
Dyess AFB/Abilene	32 25	99 51	1789	15	19	N	9	2682	100	71	98	71	23	S	96	71	75	74	73	342	1700	209	2089
Eagle Pass AFS	28 52	100 32	884	27	32	NNW	9	1423	101	73	99	73	24	ESE	98	73	78	78	77	605	2517	1426	3515
Ellington AFB/Houston	29 37	95 10	40	28	31	N	8	1384	95	78	94	78	19	S	92	78	81	80	80	114	1763	2373	3616
El Paso IAP	31 48	106 24	3918	20	24	N	7	2678	100	64	98	64	25	S	96	64	69	68	68	370	1917	0	376
Fort Bliss/Biggs AAF	31 51	106 23	3947	19	23	N	5	2432	100	65	97	65	25	W	95	65	70	69	68	325	1813	5	373
Fort Hood/Hood AAF	31 09	97 43	923	20	25	N	9	1959	99	73	97	73	23	S	95	73	77	76	75	295	1791	1045	3043
Fort Hood/Robert Gray AAF	31 04	97 50	1015	20	25	N	9	1959	99	73	97	73	23	S	95	73	77	76	75	295	1791	1045	3043
Fort Sam Houston	29 27	98 26	760	25	30	N	8	1570	99	73	97	73	22	SSE	96	73	77	76	76	397	2049	1699	3426
Fort Wolters	32 50	98 04	900	17	21	N	6	2432	102	75	100	74	24	S	98	74	78	77	76	489	1921	1136	2880
Fort Worth IAP	32 50	97 03	537	17	22	NW	11	2382	101	74	99	74	22	S	97	74	78	77	76	469	2095	1415	3087
Galveston	29 18	94 48	7	31	36	N	15	1224	90	79	89	79	9	S	88	78	81	80	80	4	2603	2998	3932
Garland ANG Station	32 54	96 39	558	18	22	NNW	10	2290	102	75	100	75	21	S	97	75	78	78	77	474	2208	1675	3103
Goodfellow AFB/San Angelo	31 26	100 24	1877	18	22	NNE	10	2240	101	71	99	71	24	SSE	97	70	75	74	73	465	1978	245	2424
Harlingen	26 14	97 39	35	35	39	NNW	10	693	96	77	94	77	18	SSE	93	77	80	79	79	223	2442	3294	4059
Hondo MAP	29 21	99 11	901	26	29	N	8	1596	99	74	97	74	22	SSE	95	74	77	77	76	480	2159	1703	3374
Houston IAP	29 58	95 21	96	27	32	NNW	11	1434	96	77	94	77	19	S	92	77	80	79	79	132	1888	2694	3695
Kelly AFB/San Antonio	29 23	98 35	690	26	29	N	8	1520	99	74	97	74	22	SSE	96	74	78	77	76	352	1920	1774	3444
Kingsville NAS	27 29	97 49	50	32	35	N	9	970	97	78	95	78	18	SE	94	78	81	80	80	258	2422	3154	3935
Lackland AFB	29 23	98 37	670	26	29	N	8	1520	99	74	97	74	22	SSE	96	74	78	77	76	352	1920	1774	3444
La Porte ANG Station	29 40	95 04	24	29	32	N	9	1284	94	78	93	78	18	S	91	78	81	80	80	66	1568	2347	3782

IV. HVAC

G. Shut-off range hood whenever possible

- All of the hoods observed have manual switches which are controlled by the kitchen personnel. Based on observations and interviews, the hoods only operate when the kitchens are in use.

IV. HVAC

H. Thermal Storage

- City Public Service utility rate for Fort Sam Houston is the Large Lighting & Power rate. This rate does not have a demand "window". Demand is measured at 15 minute intervals 24 hrs/day. Also, they offer no rebate incentives for thermal storage. Due to the above, thermal storage is not feasible at Fort Sam Houston.

VI. POWER

A. Convert to Energy Efficient/Smaller Motors

See following SimpCalc output for energy savings calculations for 3, 5, 10, 25, 50 and 100 HP motors. Due to the combined payback of over 11 years, we recommend the use of high efficiency motors only for replacement of failed motors.

Form	Facility	ECRM Desc.	Page	KWH/Yr	KW	MCF/yr	mmBtu/Yr	$/Yr	Imp.Cost	PayBack
C1-01	GENERAL	High Eff Motor	1	400	.16	.0	1.4	28	298	10.6
C1-02	GENERAL	High Eff Motor	2	475	.19	.0	1.6	33	325	9.8
C1-03	GENERAL	High Eff Motor	3	825	.33	.0	2.8	57	520	9.1
C1-04	GENERAL	High Eff Motor	4	1140	.76	.0	3.9	104	1000	9.6
C1-05	GENERAL	High Eff Motor	5	1980	1.32	.0	6.8	180	1775	9.9
C1-06	GENERAL	High Eff Motor	6	2940	1.96	.0	10.0	268	3575	13.3
		*** SUB-TOTAL ***		7760	4.72	.0	26.5	670	7493	11.2
	** GRAND TOTAL **			7760	4.72	.0	26.5	670	7493	11.2

C1-001 Replace High Efficiency Motor - GENERAL (G)

Cost Source: means cost data

Description: Install high efficiency motors.

A)	3.0 HP	Motor Nameplate Horsepower
B)	.75	Estimated Load Factor
C)	1500 Hours	Summer Operating Hours .. 10 Hrs/day x 150 Days/yr
D)	1000 Hours	Winter Operating Hours .. 10 Hrs/day x 100 Days/yr
E)	.8100	Efficiency of Old Motor (Nameplate/Table 9)
F)	.8800	Efficiency of New Motor (Manufacturer/Table 9)
G)	$ .0360 /KWH	Cost per KWH - Summer
H)	$ .0360 /KWH	Cost per KWH - Winter
I)	$ 7.50 /KW	Cost per KW - Summer
J)	$ 6.25 /KW	Cost per KW - Winter
K)	$ 298	Installed Cost of New Motor
L)	.16 KW/mo	Motor KW Reduction
M)	400 KWH/year	Motor KWH Savings
N)	1.92 KW/year	Motor KW Savings
O)	$ 28 /year	Annual Cost Savings
P)	10.6 years	Simple Payback

C1-002 Replace High Efficiency Motor - GENERAL (G)

Cost Source: means cost data

Description: Install high efficiency motors.

A)	5.0	HP	Motor Nameplate Horsepower
B)	.75		Estimated Load Factor
C)	1500	Hours	Summer Operating Hours .. 10 Hrs/day x 150 Days/yr
D)	1000	Hours	Winter Operating Hours .. 10 Hrs/day x 100 Days/yr
E)	.8300		Efficiency of Old Motor (Nameplate/Table 9)
F)	.8800		Efficiency of New Motor (Manufacturer/Table 9)
G) $	.0360	/KWH	Cost per KWH - Summer
H) $	.0360	/KWH	Cost per KWH - Winter
I) $	7.50	/KW	Cost per KW - Summer
J) $	6.25	/KW	Cost per KW - Winter
K) $	325		Installed Cost of New Motor
L)	.19	KW/mo	Motor KW Reduction
M)	475	KWH/year	Motor KWH Savings
N)	2.28	KW/year	Motor KW Savings
O) $	33	/year	Annual Cost Savings
P)	9.8	years	Simple Payback

C1-003 Replace High Efficiency Motor - GENERAL (G)

Cost Source: means cost data

Description: Install high efficiency motors.

A)	10.0 HP	Motor Nameplate Horsepower
B)	.75	Estimated Load Factor
C)	1500 Hours	Summer Operating Hours .. 10 Hrs/day x 150 Days/yr
D)	1000 Hours	Winter Operating Hours .. 10 Hrs/day x 100 Days/yr
E)	.8550	Efficiency of Old Motor (Nameplate/Table 9)
F)	.9000	Efficiency of New Motor (Manufacturer/Table 9)
G)	$ .0360 /KWH	Cost per KWH - Summer
H)	$ .0360 /KWH	Cost per KWH - Winter
I)	$ 7.50 /KW	Cost per KW - Summer
J)	$ 6.25 /KW	Cost per KW - Winter
K)	$ 520	Installed Cost of New Motor
L)	.33 KW/mo	Motor KW Reduction
M)	825 KWH/year	Motor KWH Savings
N)	3.96 KW/year	Motor KW Savings
O)	$ 57 /year	Annual Cost Savings
P)	9.1 years	Simple Payback

C1-004 Replace High Efficiency Motor - GENERAL (G)

Cost Source: means cost data

Description: Install high efficiency motors.

A)	25.0 HP	Motor Nameplate Horsepower
B)	.75	Estimated Load Factor
C)	1500 Hours	Summer Operating Hours .. 10 Hrs/day x 150 Days/yr
D)	0 Hours	Winter Operating Hours .. 10 Hrs/day x 0 Days/yr
E)	.8850	Efficiency of Old Motor (Nameplate/Table 9)
F)	.9300	Efficiency of New Motor (Manufacturer/Table 9)
G)	$ .0360 /KWH	Cost per KWH - Summer
H)	$ .0360 /KWH	Cost per KWH - Winter
I)	$ 7.50 /KW	Cost per KW - Summer
J)	$ 6.25 /KW	Cost per KW - Winter
K)	$ 1000	Installed Cost of New Motor
L)	.76 KW/mo	Motor KW Reduction
M)	1140 KWH/year	Motor KWH Savings
N)	9.12 KW/year	Motor KW Savings
O)	$ 104 /year	Annual Cost Savings
P)	9.6 years	Simple Payback

C1-005 Replace High Efficiency Motor - GENERAL (G)

Cost Source: means cost data

Description: Install high efficiency motors.

A)	50.0	HP	Motor Nameplate Horsepower
B)	.75		Estimated Load Factor
C)	1500	Hours	Summer Operating Hours .. 10 Hrs/day x 150 Days/yr
D)	0	Hours	Winter Operating Hours .. 10 Hrs/day x 0 Days/yr
E)	.9000		Efficiency of Old Motor (Nameplate/Table 9)
F)	.9400		Efficiency of New Motor (Manufacturer/Table 9)
G)	$ .0360	/KWH	Cost per KWH - Summer
H)	$ .0360	/KWH	Cost per KWH - Winter
I)	$ 7.50	/KW	Cost per KW - Summer
J)	$ 6.25	/KW	Cost per KW - Winter
K)	$ 1775		Installed Cost of New Motor
L)	1.32	KW/mo	Motor KW Reduction
M)	1980	KWH/year	Motor KWH Savings
N)	15.84	KW/year	Motor KW Savings
O)	$ 180	/year	Annual Cost Savings
P)	9.9	years	Simple Payback

C1-006 Replace High Efficiency Motor - GENERAL (G)

Cost Source: means cost data

Description: Install high efficiency motors.

A)	100.0 HP	Motor Nameplate Horsepower
B)	.75	Estimated Load Factor
C)	1500 Hours	Summer Operating Hours .. 10 Hrs/day x 150 Days/yr
D)	0 Hours	Winter Operating Hours .. 10 Hrs/day x 0 Days/yr
E)	.9100	Efficiency of Old Motor (Nameplate/Table 9)
F)	.9400	Efficiency of New Motor (Manufacturer/Table 9)
G)	$ .0360 /KWH	Cost per KWH - Summer
H)	$ .0360 /KWH	Cost per KWH - Winter
I)	$ 7.50 /KW	Cost per KW - Summer
J)	$ 6.25 /KW	Cost per KW - Winter
K)	$ 3575	Installed Cost of New Motor
L)	1.96 KW/mo	Motor KW Reduction
M)	2940 KWH/year	Motor KWH Savings
N)	23.52 KW/year	Motor KW Savings
O)	$ 268 /year	Annual Cost Savings
P)	13.3 years	Simple Payback

ELECTRIC MOTOR DATA

Hp	High Efficiency		Standard Efficiency		Heat Gain from Motors (BTUH)		
	Full Load Efficiency	kW	Full Load Efficiency	kW	Motor and Driven Equip. in Airstream	Motor Out and Driven Equip. in Airstream	Motor in and Driven Equip. Out of Airstream
1/20			35	.11	360	130	24
1/12			35	.18	580	200	38
1/8			35	.27	900	320	59
1/6			35	.36	1160	400	76
1/4			54	.35	1180	640	54
1/3			56	.44	1500	840	66
1/2			60	.62	2120	1270	85
3/4			72	.78	2650	1900	74
1	84	.90	76	1.0	3390	2550	85
1 1/2	84	1.33	78	1.45	4960	3820	114
2	84	1.78	79	1.89	6440	5090	135
3	88	2.57	81	2.76	9430	7640	179
5	88	4.19	83	4.55	15500	12700	279
7 1/2	90	6.22	84	6.66	22700	19100	364
10	90	8.29	85	8.78	29900	24500	449
15	91	12.43	87	13.01	44400	38200	621
20	91	16.58	88	17.15	58500	50900	761
25	93	20.49	88	21.19	72300	63600	868
30	93	24.59	89	25.15	85700	76350	944
40	93	32.43	89	33.53	114000	102000	1260
50	94	40.54	90	41.91	143000	127000	1570
60	94	48.65	90	50.29	172000	153000	1890
75	94	60.82	91	62.17	212000	191000	2120
100	94	81.09	91	82.89	283000	255000	2830
125	94	101.36	91	103.61	353000	318000	3530
150	94	120.32	91	122.97	420000	382000	3780
200	94		91	163.96	559000	509000	5030
250	94		91	204.95	699000	636000	6290

VII. REDUCE/ENHANCE LIGHTING

A. Photocells for Lighting

- Not recommended for the following reasons:

1. Very little exterior lighting.
2. No lights were observed on during daylight hours.
3. Most buildings already have photocells installed.

B. Timers for Lighting

- Not recommended for the following reasons:

1. Personnel doing a good job of keeping lights off in unoccupied areas.
2. Cost to install timers cannot be justified with potential savings.

E. Lower Light Fixtures

- Not recommended for the following reasons:

1. All fixtures currently either surface mounted or lay-in with 9'-10' ceilings.
2. Result would not be aesthetically acceptable.
3. Cost to lower fixtures cannot be justified by potential savings.

F. Improve Reflection with Light Colored Ceiling and Walls.

- Not recommended for the following reasons:

1. Most reflectances are fairly high.
2. Only candidate is Building 2841 bar area which has a special black ceiling installed for atmosphere.

VIII. IMPROVE LIGHTING CONTROLS

A. Install Occupancy Sensors

1. Only potential for savings is large dining halls.

2. One sensor can cover 1,200 square feet.

3. One sensor can control a maximum of 10 fixtures with the typical fixture layout.

4. Estimated savings is 1.5 hours per day of burn time.

<u>SAVINGS</u>

$$Energy\ Savings = \frac{10\,Fixtures \times 112\,watts/Fixture \times 1.5\,Hr/Day \times 250\,Day/Yr}{1000\,watts/KW}$$

$$Energy\ Savings = 420\,KWH$$

$$Cost\ Savings = 420 \times \$.036/KWH$$

$$Cost\ Savings = \$15.12/yr$$

<u>Implementation Cost</u>

(See following Cost Estimate)
Implementation Cost = $299.00

<u>Simple Payback</u>

$$Simple\ Payback = \frac{\$299.00}{\$15.12} = 19.8\,Years$$

Based on the high payback this ECO is not recommended.

CARTER & BURGESS COST ESTIMATING ANALYSIS

PROJECT NAME: FORT SAM HOUSTON EEAP	PROJECT NO: 91109912F
PROJECT LOCATION: SAN ANTONIO, TEXAS	ESTIMATOR: S.P. CLARK
SUBMITTAL: 35.0%	DATE: 27-Oct-93
ECO NO/ BUILDING: VIII. A. / GEN	CHECKED BY: DJY

TASK DESCRIPTION	QUANTITY		LABOR				MATERIALS		TOTAL COST
	NO/UN	UNIT	MH UN	HRS	UN PRICE	COST	UN PRICE	COST	
						0.00		0.00	0
						0.00		0.00	0
SENSOR	1	EA			46.00	46.00	80.00	80.00	126
POWER PACK	1	EA			45.00	45.00	28.00	28.00	73
RELAY	1	EA			17.4	17.40	21.35	21.35	39
WIRE	20	LF			0.33	6.60	0.22	4.40	11
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
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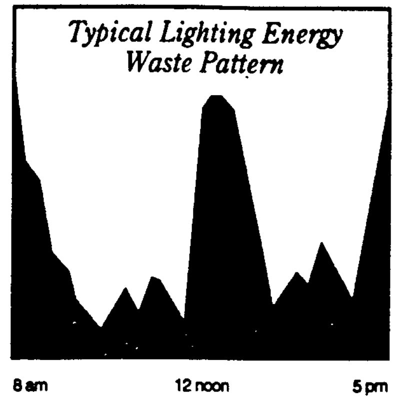
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
SUBTOTAL						$115		$134	$249
CONTENGENCY	10.00%								$25
OVERHEAD & PROFIT	10.00%								$25
TOTAL									$299

The Benefits of Lighting Control



Dark areas represent the times when offices are typically unoccupied – turning lights off in unoccupied areas saves energy and money.

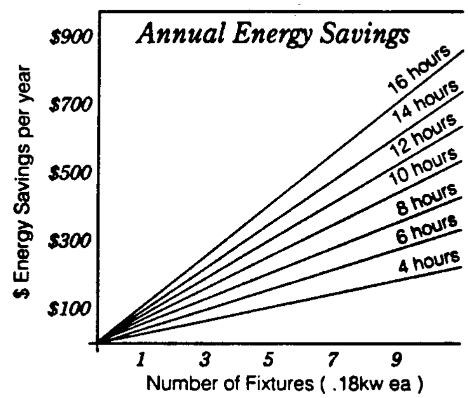
Lighting consumes about 40% of the electricity in a typical commercial building. Reducing this consumption will have an impact on the cost of running a building and on the environment.

The major source of wasted lighting energy is lights left on in unoccupied areas – a very common practice. Lighting control is needed to stop this waste.

Methods of Lighting Control

Some methods of lighting control, such as timeclocks and computerized controls, work by turning lights on in the morning and off after the custodians make their rounds in the evening.

However, these systems are inflexible. Varying work schedules often prompt overriding of the controls or schedules in such a way as to eliminate large energy savings. Also, they do not turn lights off in vacant spaces during business hours.



Hours shown represent hours of lighting use saved with occupancy sensors and depend on energy waste patterns. Savings are based on $0.08 Kwh rate.

Occupancy Sensor Advantages

The method of lighting control that has been proven to provide the greatest energy savings, flexibility, and convenience is occupancy sensors. These devices turn lighting on when a person enters a controlled area and off after the area is vacated.

Energy savings are greater with occupancy sensors because during business hours, lighting will only be on when an area is occupied. As people go to meetings or to lunch, or whenever an area is vacated, the lighting for the space will turn off.

Today, occupancy sensors are being used to control lighting and HVAC in all building applications. Offices, conference rooms, restrooms, open office areas, warehouses, classrooms – almost every space within a building – can use occupancy sensors and save energy and money.

Perfecting Lighting Control

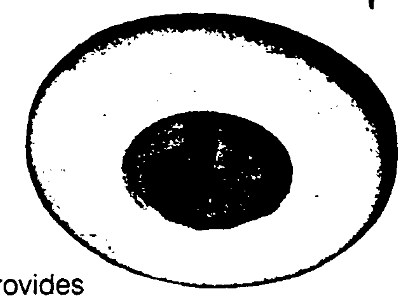
Choosing occupancy sensors is the first step in achieving lighting control success. Next comes the choice of the correct sensors that utilize the proper technologies and needed features. Each technology functions best in certain applications so combinations of sensors are needed to control lighting for an entire building.

The Watt Stopper manufactures the most comprehensive line of occupancy sensors using Passive Infrared and Ultrasonic technologies and our own innovative Dual Technology. In addition, our sensors are available with features and options that increase energy savings and user convenience. These include built-in light level sensing, bi-level lighting control, isolated relays for HVAC and EMS interface, user choice of coverage pattern, digital time-delay and sensitivity controls, and many others.

Furthermore, our engineers pay close attention to the market's changing needs and to all comments and suggestions thereby spending countless hours making improvements and developing new products. The Watt Stopper is striving toward our goal of perfecting lighting control – lighting control that is reliable and convenient and is the simplest to install, adjust and to maintain.

$80 +$5 power pack

CI-200 360° Passive Infrared Occupancy Sensor



The CI-200 is a full-featured, PIR occupancy sensor which provides 360° coverage. The sensor has an extremely low profile appearance and protrudes less than .4 inches from the ceiling.

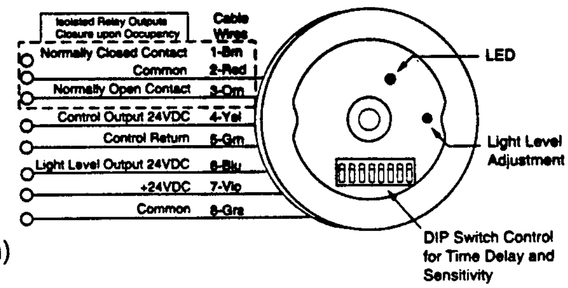
The CI-200 controls lighting through a Watt Stopper power pack and low voltage wiring. It turns lighting on when a person enters the controlled area and off when the area is vacated. It contains a built-in light level sensor which keeps lighting off when ambient light levels are adequate. The CI-200 also contains an isolated relay which allows the sensor to interface with HVAC or EMS systems. User-adjustable controls for unit sensitivity and time delay settings are made by a DIP switch located under the front housing.

CI-200 applications include open or partitioned office spaces, conference rooms, classrooms, and warehouses. Also, areas with high ceilings or with two-level lighting can be controlled with this sensor.

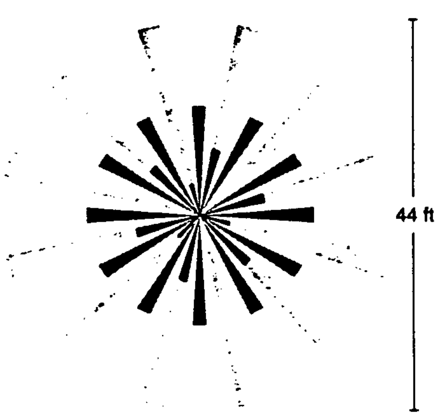
Specifications

- Advanced PIR technology
- Integrated light level sensor 2.5 to 430 fc
- Dual-element pyroelectric sensor
- Single-pole, double-throw isolated relay
- Digital time-delay DIP switch 15 sec to 30 min
- LED indicator
- Adjustable unit sensitivity with DIP switch
- Up to 3 units per power pack
- 3.3" diameter x 2.2" total depth (85mm x 56mm)
- Extends approx .36" from ceiling
- UL & CSA listed; 5 Year Warranty

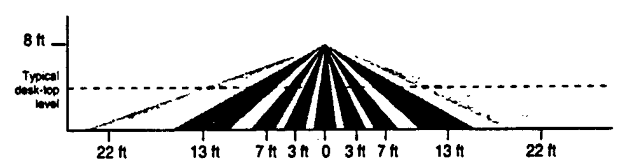
CI-200 Wiring Diagram & Controls



Coverage Pattern

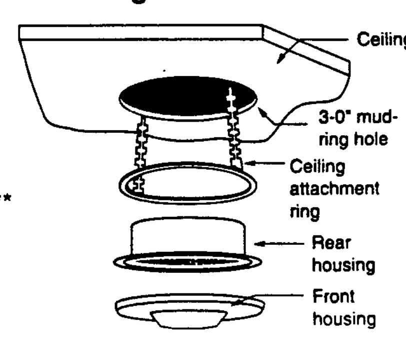


Coverage Side View



**Coverage shown represents half-step, walking motion and can reach a maximum of 1200 sq ft. Coverage for typical, desk-top level of activity is 500 sq ft.

Mounting

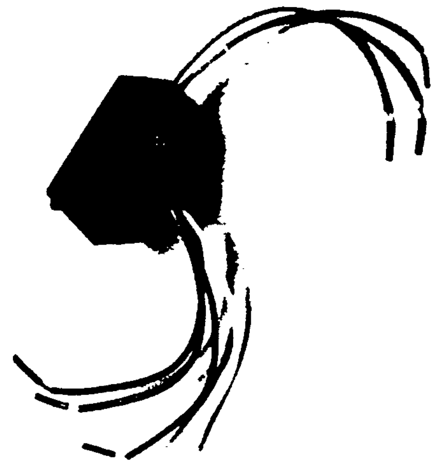


Order Information

CATALOG #	VOLTAGE	CURRENT	COVERAGE**
CI-200	24 VDC	26 mA	1200 sq ft
CI-2R7P	24 VDC halfwave	26 mA	1200 sq ft

All units are white. CI-200 uses Watt Stopper power packs

Watt Stopper Power and Slave Packs



Watt Stopper power packs provide 24VDC operating voltage to all Watt Stopper 24VDC sensors and are capable of switching up to 20 Amps of electrical load. Slave packs are identical to power packs but have no transformer power supply.

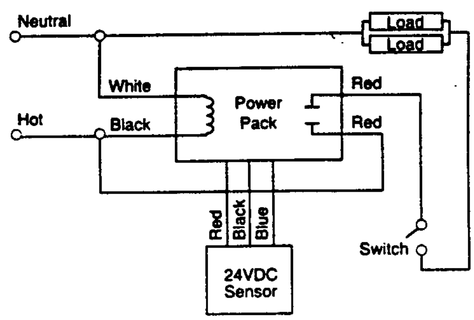
Power packs consist of a transformer and high-current relay combined in one small, powerful package. The transformer has a primary high voltage input and a secondary 24VDC, 100mA output. The secondary voltage provides operating power to Watt Stopper sensors. When the occupancy sensors detect motion, they electrically close an internal circuit which sends 24VDC back to the power or slave packs which control the lighting.

Power packs are available for 120, 220 to 240, 277 and 347 volt systems. They are housed in ABS, UL rated 94V-0 plastic enclosures. A 1/2 inch "snap-in" nipple on the power pack mounts to standard electrical enclosures with 1/2 inch knockouts.

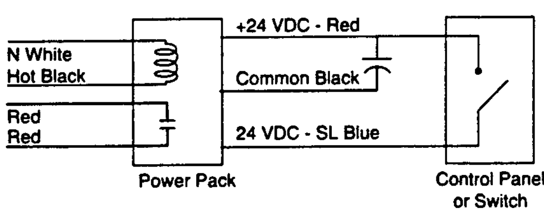
Specifications

- Self-contained transformer relay system
- Easy snap-in installation
- Secondary voltage: 24 VDC
- Secondary output: 100mA
- Switches up to 20 Amps of electrical load
- Enclosure: UL rated 94V-0 plastic enclosure
- 1.75" x 2.75" x 1.5" (45mm x 70mm x 38mm)
- UL and CSA listed
- 5 year warranty

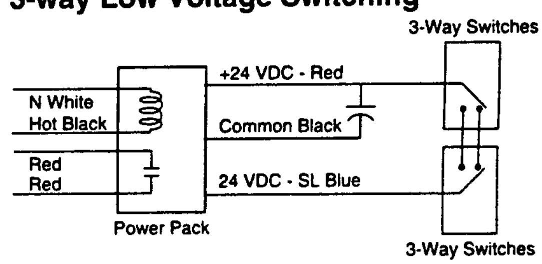
Ceiling Sensor Wiring Diagram



Low Voltage System Control



3-way Low Voltage Switching



Order Information

CATALOG #	DESC	VOLTAGE	BALLAST	INCAN	GNRL	MOTOR	OUTPUT VDC
A120-E	Power Pack	120	20	13	13	1 HP	24 VDC; 100ma
A277-E	Power Pack	277	20	-	13	1 HP	24 VDC; 100ma
A230-D	Power Pack	220-240	20	10	13	1 HP	24 VDC; 100ma
A347-D	Power Pack	347	15	-	13	1 HP	24 VDC; 100ma
S-120/277 /347-E	Slave Pack	120/277 /347	20	13	13	1 HP	-

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For plenum wire, add **-PLENUM** to Catalog #.

VIII. IMPROVE LIGHTING CONTROLS

B. Separate Switches to Control Lighting

- The existing switches are grouped logically and there is no justification for changing the existing control arrangements.

X. REFRIGERATION EQUIPMENT

A. Improve Efficiency of Refrigeration Equipment

1. All existing refrigeration equipment contain reciprocating compressors. There have been no dramatic improvements in efficiency in the last 50 years.

2. Most compressors are R-11 or R-502, recommendation is to phase out due to CFC's, in lieu of energy savings.

nal line sizes and configuration should be carefully selected to smooth gas pulses, reflect waves, and eliminate conditions of resonance.

Chapter 52 in the 1987 HVAC Volume has further information.

Shock

In designing for shock, three types of dynamic loads are recognized:

1. Suddenly applied loads of short duration
2. Suddenly applied loads of long duration
3. Sustained periodic varying loads

Since the forces are primarily inertial, the basic approach is to maintain low equipment mass and make the strength of the carrying structure as great as possible. The degree to which this practice is followed is a function of the amount of shock loading.

Commercial Units. The major shock loading to these units occurs during shipment or when they operate on commercial carriers. Train service provides a severe test because of low forcing frequencies and high shock load. Shock loads as high as 10 g have been recorded; 5 g can be expected.

Trucking service results in higher forcing frequencies, but shock loads can be equal to, or greater than, those for rail transportation.

Aircraft service forcing frequencies generally fall in the range of 20 to 60 Hz with shocks to 3 g.

Military Units. The requirements are given in detail in specifications that exceed anything expected of commercial units. In severe applications, deformation of the supporting members and shock isolators may be tolerated, provided that the unit performs its function.

Basically, the compressor must be made of components rigid enough to avoid misalignment or deformation during shock loading. Therefore, structures with low natural frequencies should be avoided.

Testing

Testing for ratings must be in accordance with the ASHRAE *Standard* 23-78, *Methods of Testing for Rating Positive Displacement Refrigerant Compressors.* Compressor tests are of two types: the first determines capacity, efficiency, sound level, motor temperatures, etc.; the second determines the probable life of the machine. Life testing should be conducted under conditions simulating those under which the compressor must operate; it generally goes on for years. A minimum set of conditions should include maximum discharge, maximum suction pressure operation, a medium condition with wet return gas, minimum suction, and a high discharge pressure condition with maximum suction gas temperature. In addition, most manufacturers run field trials and special tests (excessive floodback, flooded startups, starts and stops, and reversals) to prove new designs.

Where good correlation with actual field experience and long-term life tests can be shown, accelerated life tests can shorten the required test time.

Standard Rating Conditions

To establish a uniform industry-wide basis for rating compressors, the Air-Conditioning and Refrigeration Institute (ARI) has established standard rating conditions.

PART II: RECIPROCATING COMPRESSORS

Most reciprocating compressors are single-acting, using pistons that are driven directly through a pin and connecting rod from the crankshaft. Double-acting compressors that use piston rods, crossheads, stuffing boxes, and oil injection are not used extensively and, therefore, are not covered here.

Single-Stage compressors can achieve saturated suction temperatures to −50°F (−46°C) at 95°F (35°C) saturated condensing temperature by using R-502. Chapters 3 and 4 of the 1986 REFRIGERATION Volume have additional information on other halocarbon and ammonia systems.

Booster compressors are typically used for low-temperature applications with R-22 or ammonia. Minus 85°F (−65°C) saturated suction can be achieved by using R-22, and −65°F (−54°C) saturated suction is possible by using ammonia.

The booster raises the refrigerant pressure to the level where further compression can be achieved with a high-stage compressor without exceeding the compression-ratio limitations of the respective machines.

Since superheat is generated as a result of compression in the booster, intercooling is normally required to reduce the refrigerant stream temperature to the practical level required at the inlet to the high-stage unit. Intercooling methods include controlled liquid injection into the intermediate stream, gas bubbling through a liquid reservoir, and use of a liquid-to-gas heat exchanger where no fluid mixing occurs.

Integral Two-Stage compressors achieve low temperature (−80°F [−62°C], using R-22 or ammonia) within the frame of a single compressor. The cylinders within the compressor are divided into respective groups so that the combination of volumetric flow and pressure ratios are balanced to achieve booster and high-stage performance effectively. Refrigerant connections between the high-pressure suction and low-pressure discharge stages allow an interstage gas cooling system to be connected to remove superheat between stages. This interconnection is similar to the methods used for individual high-stage and booster compressors.

Capacity reduction is typically achieved by cylinder unloading, as in the case of single-stage compressors. Special consideration must be given to maintaining the correct relationship between high-pressure and low-pressure stages.

The most widely used compressor is the halocarbon compressor, which is manufactured in three types of design: (1) open, (2) semihermetic or bolted hermetic, and (3) the welded-shell hermetic.

Ammonia compressors are manufactured only in the open design because of the incompatibility of the refrigerant and hermetic motor materials.

Open-Type compressors are those in which the shaft extends through a seal in the crankcase for an external drive.

Hermetic compressors are those in which the motor and compressor are contained within the same pressure vessel, with the motor shaft integral with the compressor crankshaft and the motor in contact with the refrigerant.

A **semihermetic compressor** (bolted, accessible, or serviceable) is a hermetic compressor of bolted construction amenable to field repair.

In **welded-shell hermetic compressors** (sealed) the motor-compressor is mounted inside a steel shell, which, in turn is sealed by welding. (Combinations of design features used are shown in Table 1. Typical performance values for halocarbon compressors are given in Table 2.)

Table 1 Typical Design Features of Reciprocating Compressors

Item	Halocarbon Compressor Open	Halocarbon Compressor Semi-hermetic	Halocarbon Compressor Welded Hermetic	Ammonia Compressor Open
1. Number of cylinders—one to:	16	12	6	16
2. Power range	0.167 hp (0.12 kW) up	0.5 to 150 hp (0.37 to 112 kW)	0.167 to 25 hp (0.12 to 18.7 kW)	10 hp (7.5 kW) up
3. Cylinder arrangement				
a. Vertical, V or W, radial	x	x		
b. Radial, horizontal opposed			x	
c. Horizontal, vertical V or W				x
4. Drive				
a. Hermetic compressors, induction electric motor		x	x	
b. Open compressors—direct drive, V belt chain, gear, by electric motor or engine	x			x
5. Lubrication—splash or force feed, flood	x	x	x	x
6. Suction and discharge valves—ring plate or ring or reed flexing	x	x	x	x
7. Suction and discharge valve arrangement				
a. Suction and discharge valves in head	x	x	x	x
b. Uniflow—suction valves in top of piston, suction gas entering through cylinder walls. Discharge valves in head	x			x
8. Cylinder cooling				
a. Suction gas cooled	x	x	x	x
b. Water jacket cylinder wall, head, or cylinder wall and head	x			x
c. Air cooled	x	x	x	x
d. Refrigerant cooled heads	x			x
9. Cylinder head				
a. Spring loaded	x	x	x	x
b. Bolted head	x	x	x	x
10. Bearings				
a. sleeve, anti-friction	x	x	x	x
b. tapered roller	x			x

Item	Halocarbon Compressor Open	Halocarbon Compressor Semi-hermetic	Halocarbon Compressor Welded Hermetic	Ammonia Compressor Open
11. Capacity control, if provided—manual or automatic				
a. Suction valve lifting	x	x	x	x
b. Bypass—cylinder heads to suction	x	x	x	x
c. Closing inlet	x	x		x
d. Adjustable clearance	x	x		x
e. Variable speed	x	x	x	x
12. Materials				
Motor insulations and rubber materials must be compatible with refrigerant and oil mixtures. Otherwise, no restrictions	x	x	x	
No copper or brass				x
13. Oil return				
a. Crankcase separated from suction manifolds, oil return check valves, equalizers, spinners, foam breakers	x	x		x
b. Crankcase common with suction manifold			x	
14. Synchronous speeds (50 and 60 Hz)	250 to 3600	1500 to 3600	1500 to 3600	250 to 3600
15. Pistons				
a. Aluminum or cast iron	x	x	x	x
b. Ringless	x	x	x	x
c. Compression and oil control rings	x	x	x	x
16. Connecting rod				
Split rod with removable cap or solid eccentric strap	x	x	x	x
17. Mounting				
Internal spring mount		x	x	
External spring mount		x	x	
Rigidly mounted on base	x	x		x

Table 2 Typical Performance Values

Compressor Size and Type		Evap. Temp. −40°F (−40°C) Cond. Temp. 105°F (40.5°C) Suction Gas 65°F (18.3°C) Subcooling 0°F (0°C) R-12, 500, 502	Evap. Temp. 0°F (−17.8°C) Cond. Temp. 110°F (43.3°C) Suction Gas 65°F (18.3°C) Subcooling 0°F (0°C) R-12, 500, 502	Evap. Temp. 40°F (4.4°C) Cond. Temp. 105°F (40.5°C) Suction Gas 55°F (12.8°C) Subcooling 0°F (0°C) R-12, 500, 502, 22	Evap. Temp. 45°F (7.2°C) Cond. Temp. 130°F (54.4°C) Suction Gas 65°F (18.3°C) Subcooling 0°F (0°C) R-12, 500, 502, 22
Large, over 25 hp (19 kW)	Open	0.21 tons/hp (0.99 W/W)	0.40 tons/hp (1.89 W/W)	0.91 tons/hp (4.29 W/W)	0.74 tons/hp (3.49 W/W)
	Hermetic	3.15 Btu/h per W (0.92 W/W)	6.00 Btu/h per W (1.76 W/W)	13.12 Btu/h per W (3.85 W/W)	9.90 Btu/h per W (2.90 W/W)
Medium, 5 to 25 hp (4 to 19 kW)	Open	0.19 tons/hp (0.90 W/W)	0.37 tons/hp (1.74 W/W)	0.83 ton/hp (3.91 W/W)	0.65 tons/hp (3.06 W/W)
	Hermetic	2.89 Btu/h per W (0.85 W/W)	5.60 Btu/h per W (1.64 W/W)	12.04 Btu/h per W (3.53 W/W)	9.15 Btu/h per W (2.68 W/W)
Small, under 5 hp (4 kW)	Open	—	—	—	—
	Hermetic	—	3.80 Btu/h per W (1.11 W/W)	10.14 Btu/h per W (2.97 W/W)	7.76 Btu/h per W (2.27 W/W)

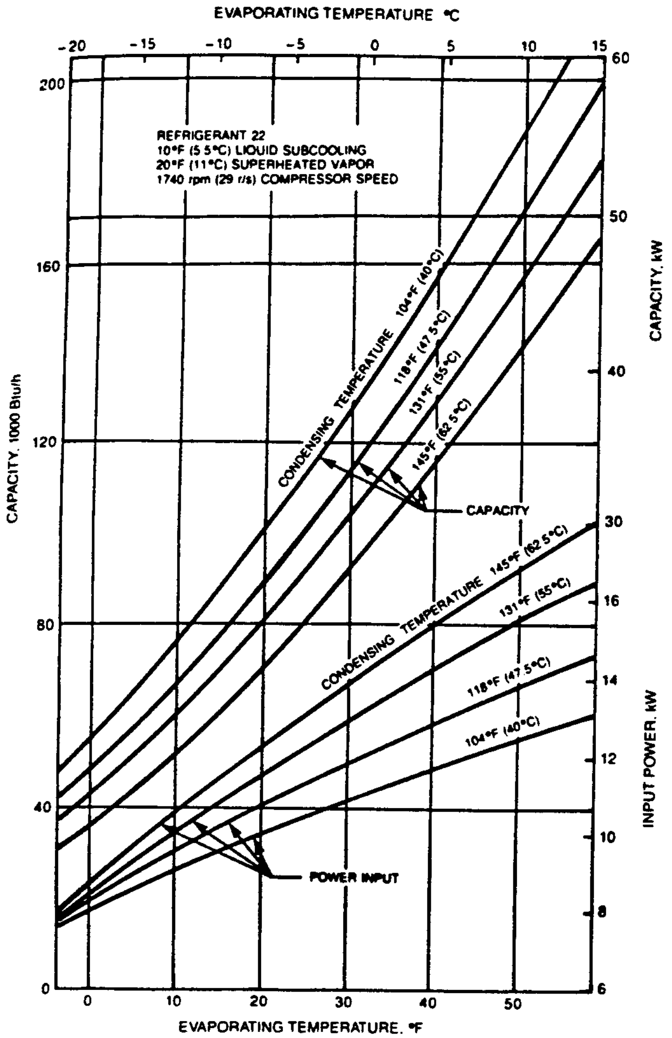

Fig. 1 Capacity and Power-Input Curves for a Typical Hermetic Reciprocating Compressor

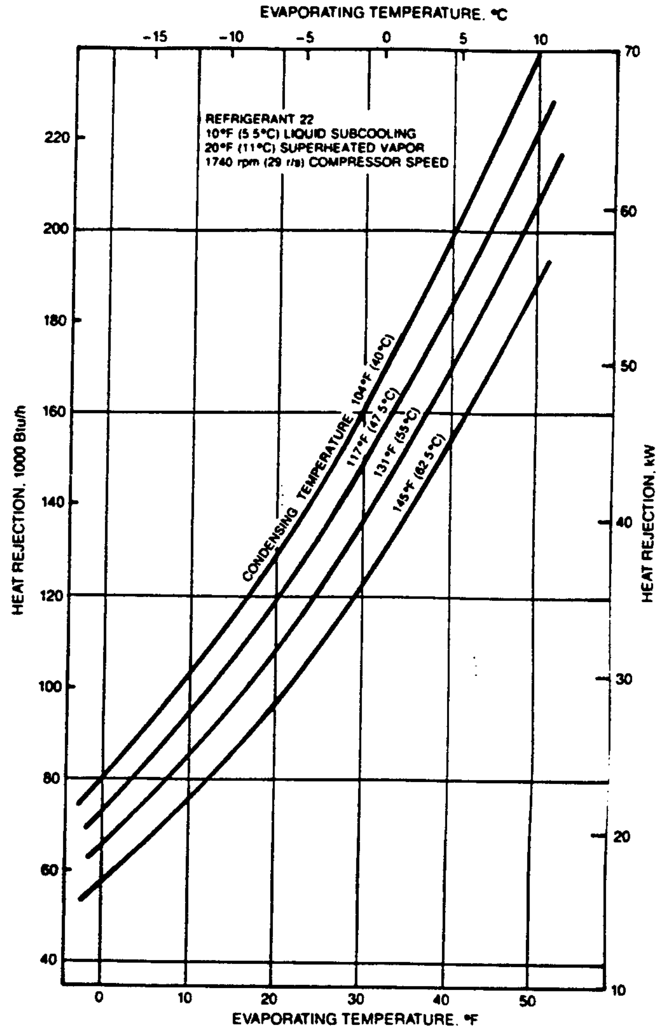

Fig. 2 Heat-Rejection Curves for a Typical Hermetic Reciprocating Compressor

PRESENTATION OF PERFORMANCE DATA

Figure 1 presents a typical set of capacity and power curves for a four-cylinder semihermetic compressor, 2.38-in. (60.3-mm) bore, 1.75-in. (44.4-mm) stroke, 1720 rpm, operating with Refrigerant 22. Figure 2 shows the heat rejection curves for the same compressor. Compressor curves should be labeled with the following information:

1. Compressor identification
2. Degrees subcooling or statement that data have been corrected to zero degrees subcooling
3. Compressor speed
4. Type refrigerant
5. Suction gas superheat
6. Compressor ambient
7. External cooling requirements (if any)
8. Maximum power or maximum operating conditions
9. Minimum operating conditions at fully loaded and fully unloaded operation

MOTOR PERFORMANCE

The motor efficiency is usually the result of a compromise between cost and size. Generally, the larger a motor is for a given rating, the more efficient it can be made. Accepted efficiencies range from approximately 80% for a 3 hp (2.25 kW) motor to 92% for a 100 hp (75 kW) motor. Uneven loading has a marked effect on motor efficiency. It is important that cylinders be spaced evenly. Also, the more cylinders there are, the smaller the impulses become. Greater moments of inertia of moving parts and higher speeds reduce the impulse effect. Small and evenly spaced impulses also help reduce noise and vibration.

Since many compressors start against load, it is desirable to estimate starting torque requirements. The following equation is for a single cylinder compressor. It neglects friction, the additional torque required to force discharge gas out of the cylinder, and the fact that the tangential force at the crankpin is not always equal to the normal force at the piston. This equation also assumes considerable gas leakage at the discharge valves but little or no leakage past the piston rings or suction valves. It yields a conservative estimate.

$$T_s = \frac{(P_2 - P_1)As}{2N_2/N_1} \quad (4)$$

where

T_s = starting torque, lb in. (N • m)
P_2 = discharge pressure, psi (Pa), absolute or gauge
P_1 = suction pressure, psi (Pa), absolute or gauge
A = area of cylinder, in.^{2} (m^2)
s = stroke of compressor, in. (m)
N_2 = motor speed, rpm
N_1 = compressor speed, rpm

Equation 4 shows that when pressures in the system are balanced or almost equal ($P_2 = P_1$), torque requirements are considerably reduced. Thus, a pressure balancing device on an expansion valve or a capillary tube that equalizes pressures at shutdown allows the compressor to be started without excessive effort. For multicylinder compressors, an analysis must be made of both the number of cylinders that might be on a compression stroke and the position of the rods at start. Since the force needed to push the piston to the top dead center is a function of how far the rod is away from the cylinder centerline, the worst possible angles these might assume need to be graphically determined by torque-effort diagrams. The torques for some arrangements are shown below:

No. Cylinders	Arrangement of Cranks	Angle between Cylinders	Approx. Torque from Equation 4
1	Single	.	T_s
2	Single	90°	$1.025T_s$
2	180° apart	0° or 180°	T_s
3	Single	60°	$1.225T_s$
3	120° apart	120°	T_s
4	180°, 2 rods/crank	90°	$1.025T_s$
6	180°, 3 rods/crank	60°	$1.23T_s$

Pull-up torque is as important as starting torque. It is required to accelerate the compressor from rest, overcoming both inertia and gas forces to bring itself to operating speed. The greatest pull-up torque requirement comes when starting a compressor at a pressure ratio of about 2:1.

FEATURES

Crankcases

The crankcase, or in a welded hermetic compressor, the cylinder block, is usually of cast iron. Aluminum is also used, particularly in small open and welded hermetic compressors. Open and semihermetic crankcases enclose the running gear, oil sump and, in the latter case, the hermetic motor. Access openings with removable covers are provided for assembly and service purposes. Welded hermetic cylinder blocks are often just skeletons, consisting of the cylinders, the main bearings, and either a barrel into which the hermetic motor stator is inserted or a surface to which the stator can be bolted.

The cylinders can be integral with the crankcase or cylinder block, in which case a material that provides a good sealing surface and resists wear must be provided. In aluminum crankcases, cast-in liners of iron or steel are usual. In large compressors, premachined cylinder sleeves inserted in the crankcase are common. With halocarbon refrigerants, excessive cylinder wear or scoring is not much of a problem and the choice of integral cylinders or inserted sleeves is often based on manufacturing considerations.

Crankshafts

Crankshafts are made of either forged steel with hardened bearing surfaces finished to 8 microinches (0.203 μm) or iron castings. Grade 25 to 40 (25,000 to 40,000 psi or 170 to 275 MPa) tensile gray iron can be used where the lower modulus of elasticity can be tolerated. Nodular iron shafts approach the stiffness, strength, and ductility of steel and should be polished in both directions of rotation to 16 microinches (0.406 μm) maximum for best results. Crankshafts often include counterweights and should be dynamically and/or statically balanced.

While a safe maximum stress is important in shaft design, it is equally important to prevent excessive deflection that can edge-load bearings to failure. In hermetics, deflection can permit motor air gap to become eccentric, which affects starting, reduces efficiency, produces noise, and further increases bearing edge-loading.

Generally, the harder the bearing material used, the harder the shaft. With bronze bearings, a journal hardness of 350 Brinell is usual, while unhardened shafts at 200 Brinell in babbitt bearings are typical. Other combinations of materials and hardnesses have been used successfully.

Main Bearings

It is possible to overhang both the crank and drive means with the bearings between; however, usual practice is to place the cylinders between the main bearings and, in a hermetic, to overhang the motor. Main bearings are made of steel-backed babbitt, steel-backed or solid bronze, or aluminum. In an aluminum crankcase, the bearings are usually integral. By automotive standards, unit loadings are low; however, the oil-refrigerant mixture frequently provides only marginal lubrication and 8000 h/yr operation in commercial refrigeration service is quite possible. For conventional shaft diameters and speeds, 600 psi (4.1 MPa), main bearing loading based on projected area is not unusual. Running clearances average 0.001 in./in. (1 mm/m) of diameter with steel-backed babbitt bearings and a steel or iron shaft. Bearing oil grooves placed in the unloaded area are usual. Feeding oil to the bearing is only one requirement, another is the venting of evolved refrigerant gas and oil escape from the bearing to carry away heat.

In most compressors, crankshaft thrust surfaces (with or without thrust washers) must be provided in addition to main bearings. Thrust washers may be steel-backed babbitt, bronze, aluminum, hardened steel, or polymer and are usually stationary. Oil grooves are often included in the thrust face.

Connecting Rods and Eccentric Straps

Connecting rods have the large end split and a bolted cap for assembly. Unsplit eccentric straps require the crankshaft to be passed through the big bore at assembly. Rods or straps are of steel, aluminum, bronze, nodular iron, or gray iron. Steel or iron rods often require inserts of such bearing material as steel-backed babbitt or bronze, while aluminum and bronze rods can bear directly on the crankpin and piston pin. Refrigerant compressor service limits unit loadings to 3000 psi (20 MPa) based on projected area with a bronze bushing in the rod small bore and a hardened steel piston pin. Aluminum rod loadings at the piston pin of 2000 psi (14 MPa) have been used. Large end unit loadings are usually under 1000 psi (7 MPa).

The Scotch yoke-type of piston-rod assembly has also been used. In small compressors, it has been fabricated by hydrogen

brazing steel components. Machined aluminum components have been used in large hermetic designs.

Piston, Piston Ring, and Piston Pin

Pistons are usually made of cast iron or aluminum. Cast-iron pistons with a running clearance of 0.0004 in./in. (400 μm/m) of diameter in the cylinder will seal adequately without piston rings. With aluminum pistons, rings are required because a running clearance in the cylinder of 0.002 in./in. (2 mm/m) or more of diameter may be necessary, as determined by tests at extreme conditions. A second or third compression ring may add to power consumption with little increase in capacity; however, it may help oil control, particularly if drained. Oil scraping rings with vented grooves may also be used. Cylinder finishes are usually obtained by honing, and a 12 to 40 μin. (0.3 to 1.0 μm) range will give good ring seating. An effective oil scraper can often be obtained with a sharp corner on the piston skirt.

The minimum piston length is determined by the side thrust and is also a function of running clearance. Where clearance is large, pistons should be longer to prevent slap. An aluminum piston (with ring) having a length equal to 0.75 times the diameter, with a running clearance of 0.002 in./in. (2 mm/m) of diameter, and a rod length to crank arm ratio of 4.5, has been used successfully.

Piston pins are steel, case-hardened to Rockwell *C* 50 to 60 and ground to a 8 μin. (0.2 μm) finish or better. Pins can be restrained against rotation in either the piston bosses or the rod small end, be free in both, or be full-floating, which is usually the case with aluminum pistons and rods. Retaining rings prevent the pin from moving endwise and abrading the cylinder wall.

There is no well-defined limit to piston speed; average velocities of 1200 fpm (6 m/s), determined by multiplying twice the stroke in feet by the rpm (in metres by the r/s), have been used successfully.

Suction and Discharge Valves

The most important components in the reciprocating compressor are the suction and discharge valves. Successful designs provide long life and low pressure losses. The life of a properly made and correctly applied valve is determined by the motion and stress it undergoes in performing its function. Excessive pressure losses across the valve result from high gas velocities, poor mechanical action, or both.

For design purposes, gas velocity is defined as being equal to the bore area multiplied by the average piston speed and divided by the valve area. Permissible gas velocities through the restricted areas of the valve are left to the discretion of the designer and depend on the level of volumetric efficiency and performance desired. In general, designs with velocities up to 12,000 fpm (60 m/s) with ammonia and up to 9000 fpm (46 m/s) with Refrigerants 12 and 22 have been successful.

An ideal valve system would meet the following requirements:

1. Large flow areas with shortest possible path
2. Straight gas-flow path, no directional changes
3. Low valve mass combined with low lift for quick action
4. Symmetry of design with minimum pressure imbalance
5. No increase in clearance volume
6. Durability
7. Low cost
8. Tight sealing at ports
9. Minimum valve flutter

Most valves in use today fall in one of the following groups:

1. A **free-floating reed valve**, with backing to limit movement, seats against a flat surface with circular or elongated ports. It is simple, and stresses can be readily determined, but it is limited to relatively small ports; therefore, multiples are often used. Totally backed with a curved stop, it is a valve that can stand considerable abuse.
2. A **reed, clamped at one end**, with full backstop support or a stop at the tip to limit movement, has a more complex motion than a free-floating reed; the resulting stresses are far greater than those calculated from the curvature of the stop. Considerable care must be taken in the design to ensure adequate life.
3. A **ring valve** usually has a spring return. A free-floating ring is seldom used because of its high-leakage losses. Improved performance is obtained by using spring return, in the form of coil springs or flexing backup springs, with each valve. Ring-type valves are particularly adaptable to compressors using cylinder sleeves.
4. A **valve formed as a ring** has part of the valve structure clamped. Generally, full rings are used with one or more sets of slots arranged in circles. By clamping the center, alignment is ensured and a force is obtained that closes the valve. To limit stresses, the valve proportions, valve stops, and supports are designed to control and limit valve motion.

Lubrication

Lubrication systems range from a simple splash system to the elaborate forced-feed systems with filters, vents, and equalizers. The type of lubrication required depends largely on bearing loads and application.

For low to medium bearing loads and factory assembled systems where cleanliness can be controlled, the **splash system** gives excellent service. Bearing clearances must be larger, however; otherwise, oil does not enter the bearing readily. Thus, the splashing effect of the dippers in the oil and the freer bearings cause the compressor to operate somewhat noisily. Furthermore, the splash at high speed encourages frothing and oil pumping; this is no problem in package-type equipment, but may be in remote systems where gas lines are long.

A **flooded system** includes disks, screws, grooves, oil-ring gears, or other devices that lift the oil to the shaft or bearing level. These devices flood the bearing and are not much better than splash systems, except that the oil is not agitated as violently, so that quieter operation results. Since little or no pressure is developed by this method, it is not considered forced-feed.

In **forced-feed lubrication**, a pump-gear, vane, or plunger develops pressure, which forces oil into the bearing. Smaller bearing clearances can be used because adequate pressure feeds oil in sufficient quantity for proper bearing cooling. As a result, the compressor may be quieter in operation.

Gear pumps are used to a large extent. Spur gears are simple but tend to promote flashing of the refrigerant dissolved in the oil because of the sudden opening of the tooth volume as two teeth disengage. This disadvantage is not apparent in internal-type eccentric gear or vane pumps where a gradual opening of the suction volume takes place. The eccentric gear pump, the vane pump, or the piston pump therefore give better performance than simple gear pumps when the pump is not submerged in the oil.

Oil pumps must be made with minimum clearances to pump a mixture of gas and oil. The discharge of the pump should have

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's)

BUILDING NO. 44

ECO NO: IV. F.

ECO NAME: Install make-up air supply for kitchen areas.

SUMMARY DATA (DEPENDENT):

KWH Savings:	1,011	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	10.81	MCF/yr
Cost Savings:	$ 73	/yr
Implementation Cost:	$ 3,914	
Simple Payback:	53.4	Years
Savings to Investment: Ratio (SIR):	.33	

ECO DESCRIPTION:

Currently, the kitchen hoods in use do not contain supply air make-up. This ECO analyzes the addition of make-up air supply for the kitchen hoods.

COST SAVINGS CALCULATIONS:

(Refer to following spreadsheet)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

MODIFIED BIN METHOD CALCULATIONS

REFER TO ASHRAE 1993 FUNDAMENTALS

BLDG. NO.				44	368	407	1350	1387	1462	2399	2652
TIME OF OPERATION				6:00A 1:30P	6:00A 2:00P	7A-10P 7A-2P	4:00A 8:30P	10:00A 9:00P	9A-8:30P 9A-10:30P	5:00A 7:30P	10:00A 7:00P
DAYS/WEEK				5	5	4 , 3	6	5	5 , 2	7	4
DB RANGE	MID PT.	MC WB	HUMID RATIO	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.
100/104	102	74	0.0116	6.4	7.0	14.6	14.5	10.1	15.8	16.1	7.1
95/99	97	74	0.0126	59.4	64.8	139.8	139.4	97.9	152.8	153.4	67.7
90/94	92	74	0.0139	135.0	147.3	309.0	307.1	213.4	334.4	339.8	149.6
85/89	87	73	0.0143	173.8	189.6	418.5	418.7	296.3	461.3	458.6	202.9
80/84	82	72	0.0146	213.2	231.4	530.6	557.5	382.4	589.7	595.6	253.5
75/79	77	70	0.0142	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70/74	72	66	0.0123	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65/69	67	61	0.0101	196.1	208.4	418.7	527.9	283.1	433.6	535.7	183.2
60/64	62	56	0.0082	161.8	172.0	346.9	437.0	235.1	359.9	443.3	151.9
55/59	57	51	0.0066	132.3	140.5	288.0	363.6	196.9	300.7	367.8	126.2
50/54	52	47	0.0057	118.4	125.4	256.0	332.4	174.6	265.8	333.0	110.6
45/49	47	43	0.0050	92.0	96.8	190.1	260.7	127.1	192.8	257.6	79.5
40/44	42	38	0.0039	72.4	75.9	138.6	198.4	88.8	135.1	195.0	56.1
35/39	37	34	0.0034	44.4	46.1	75.5	120.8	44.9	68.1	116.1	28.1
30/34	32	29	0.0028	23.0	23.8	34.9	60.3	18.9	28.8	57.4	12.0
25/29	27	25	0.0023	8.3	8.4	9.6	21.3	3.8	5.8	19.4	2.4
20/24	22	20	0.0016	2.4	2.5	3.6	6.1	2.0	3.0	5.9	1.3
15/19	17	15	0.0013	0.4	0.4	0.3	0.9	0.0	0.0	0.8	0.0
10/14	12	10	0.0009	0.2	0.2	0.1	0.4	0.0	0.0	0.4	0.0

ASSUMPTIONS

1) SUMMER ROOM DESIGN: 78FDB, 50%RH
2) WINTER ROOM DESIGN: 70FDB, 40%RH
3) HUMIDITY RATIOS FOR THE SPACE BASED ON SUMMER & WINTER ROOM DESIGN TEMP.

EQUIPMENT:
SMALL AIR COOLED CHILLER (3-25 TONS): 8.57 BTU/WATT-H
LARGE AIR COOLED CHILLER (25-100 TONS): 8.63 BTU/WATT-H
SMALL WATER COOLED CHILLER (25-100 TONS): 11.11 BTU/WATT-H
LARGE WATER COOLED CHILLER (>100 TONS): 12.12 BTU/WATT-H

SYSTEM TYPES FOR ABOVE BUILDINGS

BUILDING NUMBER	SYSTEM TYPE
44	SMALL AIR COOLED
368	SMALL AIR COOLED
407	LARGE AIR COOLED
1350	LARGE WATER COOLED
1387	SMALL AIR COOLED
1462	LARGE AIR COOLED
2399	LARGE WATER COOLED
2652	LARGE AIR COOLED

ASSUME 80% FROM THE CONDITIONED SPACE
EXHAUST CFM=6FTx1.5FTx100FPM=900CFM
BUILDING 44

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
720	102	78	0.0116	0.0102	18662	4879	23541	6.4	150285
720	97	78	0.0126	0.0102	14774	8364	23138	59.4	1374847
720	92	78	0.0139	0.0102	10886	12894	23780	135.0	3211383
720	87	78	0.0143	0.0102	6998	14288	21286	173.8	3700357
720	82	78	0.0146	0.0102	3110	15333	18444	213.2	3932422
720	67	70	0.0101	0.0062	2333	13591	15924	196.1	3122147
720	62	70	0.0082	0.0062	6221	6970	13190	161.8	2134018
720	57	70	0.0066	0.0062	10109	1394	11503	132.3	1521543
720	52	70	0.0057	0.0062	13997	1742	15739	118.4	1863409
720	47	70	0.0050	0.0062	17885	4182	22067	92.0	2029335
720	42	70	0.0039	0.0062	21773	8015	29788	72.4	2155629
720	37	70	0.0034	0.0062	25661	9757	35418	44.4	1571684
720	32	70	0.0027	0.0062	29549	12197	41746	23.0	959776
720	27	70	0.0023	0.0062	33437	13591	47028	8.3	388397
720	22	70	0.0017	0.0062	37325	15682	53006	2.4	127783
720	17	70	0.0013	0.0062	41213	17076	58288	0.4	20817
720	12	70	0.0009	0.0062	45101	18469	63570	0.2	11352
						TOTAL COOLING KBTU FOR THE YEAR			12369
						TOTAL HEATING KBTU FOR THE YEAR			15906
		EQUIPMENT 8.57 BTU/WATT-HR				COOLING KWH			1443

NOW 30% OF THE 720 CFM IS EXHAUSTED
EXHAUST CFM=6FTx1.5FTx100FPM=900CFM
BUILDING 44

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
215	102	78	0.0116	0.0102	5573	1457	7030	6.4	44877
215	97	78	0.0126	0.0102	4412	2497	6909	59.4	410545
215	92	78	0.0139	0.0102	3251	3850	7101	135.0	958955
215	87	78	0.0143	0.0102	2090	4266	6356	173.8	1104968
215	82	78	0.0146	0.0102	929	4579	5507	213.2	1174265
215	67	70	0.0101	0.0062	697	4058	4755	196.1	932308
215	62	70	0.0082	0.0062	1858	2081	3939	161.8	637242
215	57	70	0.0066	0.0062	3019	416	3435	132.3	454350
215	52	70	0.0057	0.0062	4180	520	4700	118.4	556435
215	47	70	0.0050	0.0062	5341	1249	6589	92.0	605982
215	42	70	0.0039	0.0062	6502	2393	8895	72.4	643695
215	37	70	0.0034	0.0062	7663	2914	10576	44.4	469322
215	32	70	0.0027	0.0062	8824	3642	12466	23.0	286600
215	27	70	0.0023	0.0062	9985	4058	14043	8.3	115980
215	22	70	0.0017	0.0062	11146	4683	15828	2.4	38158
215	17	70	0.0013	0.0062	12307	5099	17406	0.4	6216
215	12	70	0.0009	0.0062	13468	5515	18983	0.2	3390
						TOTAL COOLING KBTU FOR THE YEAR			3694
						TOTAL HEATING KBTU FOR THE YEAR			4750
		EQUIPMENT 8.57 BTU/WATT-HR				COOLING KWH			431

CARTER & BURGESS COST ESTIMATING ANALYSIS

PROJECT NAME: FORT SAM HOUSTON EEAP	PROJECT NO: 91109912F
PROJECT LOCATION: SAN ANTONIO, TEXAS	ESTIMATOR: C.M. JOHNSON
SUBMITTAL: 35.0%	DATE: 27-Oct-93
ECO NO/BUILDING:IV. F./BLDG 0044 HOOD 1	CHECKED BY: SPC

TASK DESCRIPTION	QUANTITY		LABOR				MATERIALS		TOTAL
	NO/UN	UNIT	MH UN	HRS	UN PRICE	COST	UN PRICE	COST	COST
						0.00		0.00	0
						0.00		0.00	0
1.5'X 6' HOOD	6	LF			44.50	267.00	350.00	2100.00	2367
COMB. SUPPLY EXHAUST UNIT	0.9	MCFM			140.00	126.00	775.00	697.50	824
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
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						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
SUBTOTAL						$393		$2,798	$3,191
OVERHEAD & PROFIT	10.00%								$319
TOTAL									$3,510

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 0044 – ECO IV. F.) – INSTALL MAKE-UP AIR SUPPLY FOR KITCHEN AREAS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 20 PREPARER C. M. JOHNSON

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$3,510		
B. SIOH	$193		
C. DESIGN COST	$211		
D. TOTAL COST (1A+1B+1C)	$3,914		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D-1E-1F)			$3,914

2. ENERGY SAVINGS (+)/COST(-):

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	3.45	$36	14.65	$533
B. DIST			$0	17.70	$0
C. RESID			$0	20.99	$0
D. NG	$3.31	11.15	$37	20.60	$760
E. PPG			$0	13.59	$0
F. COAL			$0	16.32	$0
G. SOLAR			$0	13.59	$0
H. GEOTH			$0	13.59	$0
I. BIOMA			$0	13.59	$0
J. REFUS			$0	13.59	$0
K. WIND			$0	13.59	$0
L. OTHER			$0	13.59	$0
M. DEMAND SAVINGS			$0	13.59	$0
N. TOTAL		14.6	$73		$1,293

3. NON ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-)	$0		
1. DISCOUNT FACTOR (TABLE A)			
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$0

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV-INGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $0

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 53.4 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $1,293

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 0.33

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): −1.6%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's)

BUILDING NO. 368

ECO NO: IV.D.2

ECO NAME: Replace RTU with higher efficiency unit.

SUMMARY DATA (DEPENDENT):

KWH Savings:	5,092	KWH/yr
Demand Savings:	52.0	KW/yr
Gas Savings:	0.	MCF/yr
Cost Savings:	$ 378	/yr
Implementation Cost:	$ 13,400	
Simple Payback:	35.4	Years

ECO DESCRIPTION:

Currently, an inefficient RTU is in use. This ECO analyzes replacing the existing RTU with a higher efficiency unit.

COST SAVINGS CALCULATIONS:

(Refer to following SimpCalc Calculations)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

Form	Facility	ECRM Desc.	Page	KWH/Yr	KW	MCF/yr	mmBtu/Yr	$/Yr	Imp.Cost	PayBack
C2-01	BLDG 0368 CAFETERIA	Low Eff Cooling	11	5092	4.33	.0	17.4	378	13400	35.4
		*** SUB-TOTAL ***		5092	4.33	.0	17.4	378	13400	35.4
	** GRAND TOTAL **			5092	4.33	.0	17.4	378	13400	35.4

C2-001 Replace Low Efficiency Heating/Cooling Units - BLDG 0368 CAFETERIA (G)

Cost Source: means cost data

Description: Replace RTU with high efficiency RTU.

A)	15.0	Tons	Cooling Tonnage of Unit to be Replaced
B)	400	MBTUH	Capacity of Existing Gas Furnace
C)	1176	Hrs/yr	Cooling Equivalent Full Load Oper Hours (Table 15)
D)	26	Hrs/yr	Heating Equivalent Full Load Oper Hours (Table 15)
E)	6	Mos/yr	Number of Cooling Months
F)	7.60	BTUH/Watt	EER of Existing Unit
G)	9.30	BTUH/Watt	EER of Replacement Unit
H)	.7500		Heating Efficiency - Existing Unit
I)	.7500		Heating Efficiency - Replacement Unit
J) $	.0360	/KWH	Cost per KWH - Summer
K) $	7.500	/KW/mo.	Cost per KW - Summer
L) $	3.41	/MCF	Cost per MCF
M) $	13400		Installed Cost of Replacement Units
N)	4.33	KW	A.C. KW Reduction
O)	5092	KWH/year	A.C. Annual Energy Savings
P)	26	KWmo/year	A.C. Annual KW Savings
Q) $	378	/year	Annual Cooling Savings
R)	0	MBTUH	Heating Consumption Reduction
S)	0	MCF/year	Annual Heating Savings
T) $	0	/year	Heating Cost Savings
U) $	378	/year	Annual Cost Savings
V)	35.4	years	Simple Payback

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's)

BUILDING NO. 368

ECO NO: IV.F (Hood 1)

ECO NAME: Install make-up air supply for kitchen areas

SUMMARY DATA (DEPENDENT):

KWH Savings:	2,291	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	102.0	MCF/yr
Cost Savings:	$ 431	/yr
Implementation Cost:	$ 14,795	
Simple Payback:	34.4	Years
Savings to Investment: Ratio (SIR):	.57	

ECO DESCRIPTION:

Currently, the kitchen hoods in use do not contain supply air make-up. This ECO analyzes the addition of make-up air supply for the kitchen hoods.

COST SAVINGS CALCULATIONS:

(Refer to following spreadsheet)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

MODIFIED BIN METHOD CALCULATIONS

REFER TO ASHRAE 1993 FUNDAMENTALS

BLDG. NO.				44	368	407	1350	1387	1462	2399	2652
TIME OF OPERATION				6:00A 1:30P	6:00A 2:00P	7A–10P 7A–2P	4:00A 8:30P	10:00A 9:00P	9A–8:30P 9A–10:30P	5:00A 7:30P	10:00A 7:00P
DAYS/WEEK				5	5	4 , 3	6	5	5 , 2	7	4
DB RANGE	MID PT.	MC WB	HUMID RATIO	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.
100/104	102	74	0.0116	6.4	7.0	14.6	14.5	10.1	15.8	16.1	7.1
95/99	97	74	0.0126	59.4	64.8	139.8	139.4	97.9	152.8	153.4	67.7
90/94	92	74	0.0139	135.0	147.3	309.0	307.1	213.4	334.4	339.8	149.6
85/89	87	73	0.0143	173.8	189.6	418.5	418.7	296.3	461.3	458.6	202.9
80/84	82	72	0.0146	213.2	231.4	530.6	557.5	382.4	589.7	595.6	253.5
75/79	77	70	0.0142	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70/74	72	66	0.0123	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65/69	67	61	0.0101	196.1	208.4	418.7	527.9	283.1	433.6	535.7	183.2
60/64	62	56	0.0082	161.8	172.0	346.9	437.0	235.1	359.9	443.3	151.9
55/59	57	51	0.0066	132.3	140.5	288.0	363.6	196.9	300.7	367.8	126.2
50/54	52	47	0.0057	118.4	125.4	256.0	332.4	174.6	265.8	333.0	110.6
45/49	47	43	0.0050	92.0	96.8	190.1	260.7	127.1	192.8	257.6	79.5
40/44	42	38	0.0039	72.4	75.9	138.6	198.4	88.8	135.1	195.0	56.1
35/39	37	34	0.0034	44.4	46.1	75.5	120.8	44.9	68.1	116.1	28.1
30/34	32	29	0.0028	23.0	23.8	34.9	60.3	18.9	28.8	57.4	12.0
25/29	27	25	0.0023	8.3	8.4	9.6	21.3	3.8	5.8	19.4	2.4
20/24	22	20	0.0016	2.4	2.5	3.6	6.1	2.0	3.0	5.9	1.3
15/19	17	15	0.0013	0.4	0.4	0.3	0.9	0.0	0.0	0.8	0.0
10/14	12	10	0.0009	0.2	0.2	0.1	0.4	0.0	0.0	0.4	0.0

ASSUMPTIONS

1) SUMMER ROOM DESIGN: 78FDB, 50%RH
2) WINTER ROOM DESIGN: 70FDB, 40%RH
3) HUMIDITY RATIOS FOR THE SPACE BASED ON SUMMER & WINTER ROOM DESIGN TEMP.

EQUIPMENT:
SMALL AIR COOLED CHILLER (3–25 TONS): 8.57 BTU/WATT–H
LARGE AIR COOLED CHILLER (25–100 TONS): 8.63 BTU/WATT–H
SMALL WATER COOLED CHILLER (25–100 TONS): 11.11 BTU/WATT–H
LARGE WATER COOLED CHILLER (>100 TONS): 12.12 BTU/WATT–H

SYSTEM TYPES FOR ABOVE BUILDINGS

BUILDING NUMBER	SYSTEM TYPE
44	SMALL AIR COOLED
368	SMALL AIR COOLED
407	LARGE AIR COOLED
1350	LARGE WATER COOLED
1387	SMALL AIR COOLED
1462	LARGE AIR COOLED
2399	LARGE WATER COOLED
2652	LARGE AIR COOLED

ASSUME 30% FROM CONDITIONED SPACE IN SUMMER AND 100% IN WINTER
EXHAUST CFM=4970
BUILDING 368

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
1500	102	78	0.0116	0.0102	38880	10164	49044	7.0	341556
1500	97	78	0.0126	0.0102	30780	17424	48204	64.8	3124652
1500	92	78	0.0139	0.0102	22680	26862	49542	147.3	7298598
1500	87	78	0.0143	0.0102	14580	29766	44346	189.6	8409902
1500	82	78	0.0146	0.0102	6480	31944	38424	231.4	8892411
4970	67	70	0.0101	0.0062	16103	93814	109917	208.4	22905818
4970	62	70	0.0082	0.0062	42941	48110	91050	172.0	15657417
4970	57	70	0.0066	0.0062	69779	9622	79401	140.5	11158637
4970	52	70	0.0057	0.0062	96617	12027	108644	125.4	13619327
4970	47	70	0.0050	0.0062	123455	28866	152321	96.8	14742454
4970	42	70	0.0039	0.0062	150293	55326	205619	75.9	15605001
4970	37	70	0.0034	0.0062	177131	67353	244484	46.1	11263738
4970	32	70	0.0027	0.0062	203969	84192	288161	23.8	6843814
4970	27	70	0.0023	0.0062	230807	93814	324621	8.4	2724494
4970	22	70	0.0017	0.0062	257645	108247	365891	2.5	914729
4970	17	70	0.0013	0.0062	284483	117869	402351	0.4	143697
4970	12	70	0.0009	0.0062	311321	127490	438811	0.2	78359
					TOTAL COOLING KBTU FOR THE YEAR				28067
					TOTAL HEATING KBTU FOR THE YEAR				115657
		EQUIPMENT 8.57 BTU/WATT-HR				COOLING KWH			3275

70% MAKEUP WITHIN HOOD, 30% FROM KITCHEN, THEN 30% OF 1500 CFM
EXHAUST CFM=4970
BUILDING 368

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
450	102	78	0.0116	0.0102	11664	3049	14713	7.0	102467
450	97	78	0.0126	0.0102	9234	5227	14461	64.8	937396
450	92	78	0.0139	0.0102	6804	8059	14863	147.3	2189579
450	87	78	0.0143	0.0102	4374	8930	13304	189.6	2522971
450	82	78	0.0146	0.0102	1944	9583	11527	231.4	2667723
450	67	70	0.0101	0.0062	1458	8494	9952	208.4	2073967
450	62	70	0.0082	0.0062	3888	4356	8244	172.0	1417674
450	57	70	0.0066	0.0062	6318	871	7189	140.5	1010339
450	52	70	0.0057	0.0062	8748	1089	9837	125.4	1233138
450	47	70	0.0050	0.0062	11178	2614	13792	96.8	1334830
450	42	70	0.0039	0.0062	13608	5009	18617	75.9	1412928
450	37	70	0.0034	0.0062	16038	6098	22136	46.1	1019856
450	32	70	0.0027	0.0062	18468	7623	26091	23.8	619661
450	27	70	0.0023	0.0062	20898	8494	29392	8.4	246685
450	22	70	0.0017	0.0062	23328	9801	33129	2.5	82823
450	17	70	0.0013	0.0062	25758	10672	36430	0.4	13011
450	12	70	0.0009	0.0062	28188	11543	39731	0.2	7095
					TOTAL COOLING KBTU FOR THE YEAR				8420
					TOTAL HEATING KBTU FOR THE YEAR				10472
		EQUIPMENT 8.57 BTU/WATT-HR				COOLING KWH			983

CARTER & BURGESS COST ESTIMATING ANALYSIS

PROJECT NAME: FORT SAM HOUSTON EEAP	PROJECT NO: 91109912F
PROJECT LOCATION: SAN ANTONIO, TEXAS	ESTIMATOR: C.M. JOHNSON
SUBMITTAL: 35.0%	DATE: 27-Oct-93
ECO NO/BUILDING:IV. F./BLDG 0368 HOOD 1	CHECKED BY: SPC

TASK DESCRIPTION	QUANTITY		LABOR				MATERIALS		TOTAL COST
	NO/UN	UNIT	MH UN	HRS	UN PRICE	COST	UN PRICE	COST	
						0.00		0.00	0
						0.00		0.00	0
7'X 15' HOOD	15	LF			44.50	667.50	500.00	7500.00	8168
COMB. SUPPLY EXHAUST UNIT	5	MCFM			119.00	595.00	660.00	3300.00	3895
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
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						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
SUBTOTAL						$1,263		$10,800	$12,063
OVERHEAD & PROFIT	10.00%								$1,206
TOTAL									$13,269

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 0368 – ECO IV. F.) – INSTALL MAKE–UP AIR SUPPLY FOR KITCHEN AREAS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 20 PREPARER C. M. JOHNSON

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$13,269		
B. SIOH	$730		
C. DESIGN COST	$796		
D. TOTAL COST (1A+1B+1C)	$14,795		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$14,795

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	7.82	$83	14.65	$1,209
B. DIST			$0	17.70	$0
C. RESID			$0	20.99	$0
D. NG	$3.31	105.19	$348	20.60	$7,172
E. PPG			$0	13.59	$0
F. COAL			$0	16.32	$0
G. SOLAR			$0	13.59	$0
H. GEOTH			$0	13.59	$0
I. BIOMA			$0	13.59	$0
J. REFUS			$0	13.59	$0
K. WIND			$0	13.59	$0
L. OTHER			$0	13.59	$0
M. DEMAND SAVINGS			$0	13.59	$0
N. TOTAL		113.01	$431		$8,381

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$0		
1. DISCOUNT FACTOR (TABLE A)			
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$0

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV–INGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $0

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 34.4 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $8,381

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 0.57

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 1.1%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's)

BUILDING NO. 368

ECO NO: IV.F (Hood 2)

ECO NAME: Install make-up air supply for kitchen areas

SUMMARY DATA (DEPENDENT):

KWH Savings:	1,834	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	18.96	MCF/yr
Cost Savings:	$ 131	/yr
Implementation Cost:	$ 3,528	
Simple Payback:	27.0	Years
Savings to Investment: Ratio (SIR):	.65	

ECO DESCRIPTION:

Currently, the kitchen hoods in use do not contain supply air make-up. This ECO analyzes the addition of make-up air supply for the kitchen hoods.

COST SAVINGS CALCULATIONS:

(Refer to following spreadsheet)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

MODIFIED BIN METHOD CALCULATIONS

REFER TO ASHRAE 1993 FUNDAMENTALS

BLDG. NO.				44	368	407	1350	1387	1462	2399	2652
TIME OF OPERATION				6:00A 1:30P	6:00A 2:00P	7A–10P 7A–2P	4:00A 8:30P	10:00A 9:00P	9A–8:30P 9A–10:30P	5:00A 7:30P	10:00A 7:00P
DAYS/WEEK				5	5	4 , 3	6	5	5 , 2	7	4
DB RANGE	MID PT.	MC WB	HUMID RATIO	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.
100/104	102	74	0.0116	6.4	7.0	14.6	14.5	10.1	15.8	16.1	7.1
95/99	97	74	0.0126	59.4	64.8	139.8	139.4	97.9	152.8	153.4	67.7
90/94	92	74	0.0139	135.0	147.3	309.0	307.1	213.4	334.4	339.8	149.6
85/89	87	73	0.0143	173.8	189.6	418.5	418.7	296.3	461.3	458.6	202.9
80/84	82	72	0.0146	213.2	231.4	530.6	557.5	382.4	589.7	595.6	253.5
75/79	77	70	0.0142	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70/74	72	66	0.0123	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65/69	67	61	0.0101	196.1	208.4	418.7	527.9	283.1	433.6	535.7	183.2
60/64	62	56	0.0082	161.8	172.0	346.9	437.0	235.1	359.9	443.3	151.9
55/59	57	51	0.0066	132.3	140.5	288.0	363.6	196.9	300.7	367.8	126.2
50/54	52	47	0.0057	118.4	125.4	256.0	332.4	174.6	265.8	333.0	110.6
45/49	47	43	0.0050	92.0	96.8	190.1	260.7	127.1	192.8	257.6	79.5
40/44	42	38	0.0039	72.4	75.9	138.6	198.4	88.8	135.1	195.0	56.1
35/39	37	34	0.0034	44.4	46.1	75.5	120.8	44.9	68.1	116.1	28.1
30/34	32	29	0.0028	23.0	23.8	34.9	60.3	18.9	28.8	57.4	12.0
25/29	27	25	0.0023	8.3	8.4	9.6	21.3	3.8	5.8	19.4	2.4
20/24	22	20	0.0016	2.4	2.5	3.6	6.1	2.0	3.0	5.9	1.3
15/19	17	15	0.0013	0.4	0.4	0.3	0.9	0.0	0.0	0.8	0.0
10/14	12	10	0.0009	0.2	0.2	0.1	0.4	0.0	0.0	0.4	0.0

ASSUMPTIONS

1) SUMMER ROOM DESIGN: 78FDB, 50%RH
2) WINTER ROOM DESIGN: 70FDB, 40%RH
3) HUMIDITY RATIOS FOR THE SPACE BASED ON SUMMER & WINTER ROOM DESIGN TEMP.

EQUIPMENT:

SMALL AIR COOLED CHILLER (3–25 TONS): 8.57 BTU/WATT–H
LARGE AIR COOLED CHILLER (25–100 TONS): 8.63 BTU/WATT–H
SMALL WATER COOLED CHILLER (25–100 TONS): 11.11 BTU/WATT–H
LARGE WATER COOLED CHILLER (>100 TONS): 12.12 BTU/WATT–H

SYSTEM TYPES FOR ABOVE BUILDINGS

BUILDING NUMBER	SYSTEM TYPE
44	SMALL AIR COOLED
368	SMALL AIR COOLED
407	LARGE AIR COOLED
1350	LARGE WATER COOLED
1387	SMALL AIR COOLED
1462	LARGE AIR COOLED
2399	LARGE WATER COOLED
2652	LARGE AIR COOLED

ASSUME 100% EXHAUST CFM FROM CONDITIONED SPACE
EXHAUST CFM=4FTx3FTx100FPM=1200CFM
BUILDING 368

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
1200	102	78	0.0116	0.0102	31104	8131	39235	7.0	273245
1200	97	78	0.0126	0.0102	24624	13939	38563	64.8	2499722
1200	92	78	0.0139	0.0102	18144	21490	39634	147.3	5838879
1200	87	78	0.0143	0.0102	11664	23813	35477	189.6	6727922
1200	82	78	0.0146	0.0102	5184	25555	30739	231.4	7113929
1200	67	70	0.0101	0.0062	3888	22651	26539	208.4	5530580
1200	62	70	0.0082	0.0062	10368	11616	21984	172.0	3780463
1200	57	70	0.0066	0.0062	16848	2323	19171	140.5	2694238
1200	52	70	0.0057	0.0062	23328	2904	26232	125.4	3288369
1200	47	70	0.0050	0.0062	29808	6970	36778	96.8	3559546
1200	42	70	0.0039	0.0062	36288	13358	49646	75.9	3767807
1200	37	70	0.0034	0.0062	42768	16262	59030	46.1	2719615
1200	32	70	0.0027	0.0062	49248	20328	69576	23.8	1652430
1200	27	70	0.0023	0.0062	55728	22651	78379	8.4	657825
1200	22	70	0.0017	0.0062	62208	26136	88344	2.5	220860
1200	17	70	0.0013	0.0062	68688	28459	97147	0.4	34695
1200	12	70	0.0009	0.0062	75168	30782	105950	0.2	18920

TOTAL COOLING KBTU FOR THE YEAR 22454
TOTAL HEATING KBTU FOR THE YEAR 27925
EQUIPMENT 8.57 BTU/WATT—HR COOLING KWH 2620

NOW 30% EXHAUST CFM FROM CONDITIONED SPACE
EXHAUST CFM=4FTx3FTx100FPM=1200CFM
BUILDING 368

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
360	102	78	0.0116	0.0102	9331	2439	11771	7.0	81974
360	97	78	0.0126	0.0102	7387	4182	11569	64.8	749917
360	92	78	0.0139	0.0102	5443	6447	11890	147.3	1751664
360	87	78	0.0143	0.0102	3499	7144	10643	189.6	2018377
360	82	78	0.0146	0.0102	1555	7667	9222	231.4	2134179
360	67	70	0.0101	0.0062	1166	6795	7962	208.4	1659174
360	62	70	0.0082	0.0062	3110	3485	6595	172.0	1134139
360	57	70	0.0066	0.0062	5054	697	5751	140.5	808271
360	52	70	0.0057	0.0062	6998	871	7870	125.4	986511
360	47	70	0.0050	0.0062	8942	2091	11033	96.8	1067864
360	42	70	0.0039	0.0062	10886	4008	14894	75.9	1130342
360	37	70	0.0034	0.0062	12830	4879	17709	46.1	815884
360	32	70	0.0027	0.0062	14774	6098	20873	23.8	495729
360	27	70	0.0023	0.0062	16718	6795	23514	8.4	197348
360	22	70	0.0017	0.0062	18662	7841	26503	2.5	66258
360	17	70	0.0013	0.0062	20606	8538	29144	0.4	10409
360	12	70	0.0009	0.0062	22550	9235	31785	0.2	5676

TOTAL COOLING KBTU FOR THE YEAR 6736
TOTAL HEATING KBTU FOR THE YEAR 8378
EQUIPMENT 8.57 BTU/WATT—HR COOLING KWH 786

CARTER & BURGESS COST ESTIMATING ANALYSIS

PROJECT NAME: FORT SAM HOUSTON EEAP	PROJECT NO: 91109912F
PROJECT LOCATION: SAN ANTONIO, TEXAS	ESTIMATOR: C.M. JOHNSON
SUBMITTAL: 35.0%	DATE: 27-Oct-93
ECO NO/BUILDING:IV. F./BLDG 0368 HOOD 2	CHECKED BY: SPC

TASK DESCRIPTION	QUANTITY		LABOR				MATERIALS		TOTAL COST
	NO/UN	UNIT	MH UN	HRS	UN PRICE	COST	UN PRICE	COST	
						0.00		0.00	0
						0.00		0.00	0
3'X 4' HOOD	4	LF			44.50	178.00	400.00	1600.00	1778
COMB. SUPPLY EXHAUST UNIT	1.2	MCFM			140.00	168.00	775.00	930.00	1098
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
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						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
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						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
SUBTOTAL						$346		$2,530	$2,876
OVERHEAD & PROFIT	10.00%								$288
TOTAL									$3,164

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 0368 – ECO IV. F.) – INSTALL MAKE–UP AIR SUPPLY FOR KITCHEN AREAS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 20 PREPARER C. M. JOHNSON

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$3,164		
B. SIOH	$174		
C. DESIGN COST	$190		
D. TOTAL COST (1A+1B+1C)	$3,528		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$3,528

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	6.26	$66	14.65	$968
B. DIST			$0	17.70	$0
C. RESID			$0	20.99	$0
D. NG	$3.31	19.55	$65	20.60	$1,333
E. PPG			$0	13.59	$0
F. COAL			$0	16.32	$0
G. SOLAR			$0	13.59	$0
H. GEOTH			$0	13.59	$0
I. BIOMA			$0	13.59	$0
J. REFUS			$0	13.59	$0
K. WIND			$0	13.59	$0
L. OTHER			$0	13.59	$0
M. DEMAND SAVINGS			$0	13.59	$0
N. TOTAL		25.81	$131		$2,301

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$0		
1. DISCOUNT FACTOR (TABLE A)			
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$0

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(–)

	ITEM	SAVINGS(+) COST(–)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV-INGS(+)COST(–)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $0

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 27.0 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $2,301

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 0.65

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 1.8%

ENERGY CONSERVATION ANALYSIS

BUILDING NO. 407

ENERGY CONSERVATION OPPORTUNITIES (ECO's)

ECO NO: IV.F (Hood 1)

ECO NAME: Install make-up air supply for kitchen areas

SUMMARY DATA (DEPENDENT):

KWH Savings:	27,217	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	242.16	MCF/yr
Cost Savings:	$ 1,806	/yr
Implementation Cost:	$ 32,155	
Simple Payback:	17.8	Years
Savings to Investment: Ratio (SIR):	.98	

ECO DESCRIPTION:

Currently, the kitchen hoods in use do not contain supply air make-up. This ECO analyzes the addition of make-up air supply for the kitchen hoods.

COST SAVINGS CALCULATIONS:

(Refer to following spreadsheet)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

MODIFIED BIN METHOD CALCULATIONS

REFER TO ASHRAE 1993 FUNDAMENTALS

BLDG. NO.				44	368	407	1350	1387	1462	2399	2652
TIME OF OPERATION				6:00A 1:30P	6:00A 2:00P	7A-10P 7A-2P	4:00A 8:30P	10:00A 9:00P	9A-8:30P 9A-10:30P	5:00A 7:30P	10:00A 7:00P
DAYS/WEEK				5	5	4 , 3	6	5	5 , 2	7	4
DB RANGE	MID PT.	MC WB	HUMID RATIO	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.
100/104	102	74	0.0116	6.4	7.0	14.6	14.5	10.1	15.8	16.1	7.1
95/99	97	74	0.0126	59.4	64.8	139.8	139.4	97.9	152.8	153.4	67.7
90/94	92	74	0.0139	135.0	147.3	309.0	307.1	213.4	334.4	339.8	149.6
85/89	87	73	0.0143	173.8	189.6	418.5	418.7	296.3	461.3	458.6	202.9
80/84	82	72	0.0146	213.2	231.4	530.6	557.5	382.4	589.7	595.6	253.5
75/79	77	70	0.0142	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70/74	72	66	0.0123	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65/69	67	61	0.0101	196.1	208.4	418.7	527.9	283.1	433.6	535.7	183.2
60/64	62	56	0.0082	161.8	172.0	346.9	437.0	235.1	359.9	443.3	151.9
55/59	57	51	0.0066	132.3	140.5	288.0	363.6	196.9	300.7	367.8	126.2
50/54	52	47	0.0057	118.4	125.4	256.0	332.4	174.6	265.8	333.0	110.6
45/49	47	43	0.0050	92.0	96.8	190.1	260.7	127.1	192.8	257.6	79.5
40/44	42	38	0.0039	72.4	75.9	138.6	198.4	88.8	135.1	195.0	56.1
35/39	37	34	0.0034	44.4	46.1	75.5	120.8	44.9	68.1	116.1	28.1
30/34	32	29	0.0028	23.0	23.8	34.9	60.3	18.9	28.8	57.4	12.0
25/29	27	25	0.0023	8.3	8.4	9.6	21.3	3.8	5.8	19.4	2.4
20/24	22	20	0.0016	2.4	2.5	3.6	6.1	2.0	3.0	5.9	1.3
15/19	17	15	0.0013	0.4	0.4	0.3	0.9	0.0	0.0	0.8	0.0
10/14	12	10	0.0009	0.2	0.2	0.1	0.4	0.0	0.0	0.4	0.0

ASSUMPTIONS

1) SUMMER ROOM DESIGN: 78FDB, 50%RH
2) WINTER ROOM DESIGN: 70FDB, 40%RH
3) HUMIDITY RATIOS FOR THE SPACE BASED ON SUMMER & WINTER ROOM DESIGN TEMP.

EQUIPMENT:

SMALL AIR COOLED CHILLER (3-25 TONS): 8.57 BTU/WATT-H
LARGE AIR COOLED CHILLER (25-100 TONS): 8.63 BTU/WATT-H
SMALL WATER COOLED CHILLER (25-100 TONS): 11.11 BTU/WATT-H
LARGE WATER COOLED CHILLER (>100 TONS): 12.12 BTU/WATT-H

SYSTEM TYPES FOR ABOVE BUILDINGS

BUILDING NUMBER	SYSTEM TYPE
44	SMALL AIR COOLED
368	SMALL AIR COOLED
407	LARGE AIR COOLED
1350	LARGE WATER COOLED
1387	SMALL AIR COOLED
1462	LARGE AIR COOLED
2399	LARGE WATER COOLED
2652	LARGE AIR COOLED

ASSUME 30% CONDITIONED AIR IS EXHAUSTED
EXHAUST CFM=9FTx30FTx100FPM=27,000CFM
BUILDING 407

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
8100	102	78	0.0116	0.0102	209952	54886	264838	14.6	3868521
8100	97	78	0.0126	0.0102	166212	94090	260302	139.8	36377149
8100	92	78	0.0139	0.0102	122472	145055	267527	309.0	82656227
8100	87	78	0.0143	0.0102	78732	160736	239468	418.5	100217525
8100	82	78	0.0146	0.0102	34992	172498	207490	530.6	110088053
8100	67	70	0.0101	0.0062	26244	152896	179140	418.7	74998713
8100	62	70	0.0082	0.0062	69984	78408	148392	346.9	51473475
8100	57	70	0.0066	0.0062	113724	15682	129406	288.0	37273434
8100	52	70	0.0057	0.0062	157464	19602	177066	256.0	45322572
8100	47	70	0.0050	0.0062	201204	47045	248249	190.1	47193870
8100	42	70	0.0039	0.0062	244944	90169	335113	138.6	46449083
8100	37	70	0.0034	0.0062	288684	109771	398455	75.5	30083368
8100	32	70	0.0027	0.0062	332424	137214	469638	34.9	16370239
8100	27	70	0.0023	0.0062	376164	152896	529060	9.6	5063856
8100	22	70	0.0017	0.0062	419904	176418	596322	3.6	2172316
8100	17	70	0.0013	0.0062	463644	192100	655744	0.3	163936
8100	12	70	0.0009	0.0062	507384	207781	715165	0.1	89396

TOTAL COOLING KBTU FOR THE YEAR 333207
TOTAL HEATING KBTU FOR THE YEAR 356654
EQUIPMENT 8.63 BTU/WATT–HR COOLING KWH 38881

NOW 30% OF THE 8100 CFM IS EXHAUSTED
EXHAUST CFM=9FTx30FTx100FPM=27,000CFM
BUILDING 407

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
2430	102	78	0.0116	0.0102	62986	16466	79451	14.6	1160556
2430	97	78	0.0126	0.0102	49864	28227	78090	139.8	10913145
2430	92	78	0.0139	0.0102	36742	43516	80258	309.0	24796868
2430	87	78	0.0143	0.0102	23620	48221	71841	418.5	30065258
2430	82	78	0.0146	0.0102	10498	51749	62247	530.6	33026416
2430	67	70	0.0101	0.0062	7873	45869	53742	418.7	22499614
2430	62	70	0.0082	0.0062	20995	23522	44518	346.9	15442043
2430	57	70	0.0066	0.0062	34117	4704	38822	288.0	11182030
2430	52	70	0.0057	0.0062	47239	5881	53120	256.0	13596772
2430	47	70	0.0050	0.0062	60361	14113	74475	190.1	14158161
2430	42	70	0.0039	0.0062	73483	27051	100534	138.6	13934725
2430	37	70	0.0034	0.0062	86605	32931	119537	75.5	9025010
2430	32	70	0.0027	0.0062	99727	41164	140891	34.9	4911072
2430	27	70	0.0023	0.0062	112849	45869	158718	9.6	1519157
2430	22	70	0.0017	0.0062	125971	52925	178897	3.6	651695
2430	17	70	0.0013	0.0062	139093	57630	196723	0.3	49181
2430	12	70	0.0009	0.0062	152215	62334	214550	0.1	26819

TOTAL COOLING KBTU FOR THE YEAR 99962
TOTAL HEATING KBTU FOR THE YEAR 106996
EQUIPMENT 8.63 BTU/WATT–HR COOLING KWH 11664

CARTER & BURGESS COST ESTIMATING ANALYSIS

PROJECT NAME: FORT SAM HOUSTON EEAP	PROJECT NO: 91109912F
PROJECT LOCATION: SAN ANTONIO, TEXAS	ESTIMATOR: C.M. JOHNSON
SUBMITTAL: 35.0%	DATE: 27-Oct-93
ECO NO/BUILDING:IV. F./BLDG 0407 HOOD 1	CHECKED BY: SPC

TASK DESCRIPTION	QUANTITY		LABOR				MATERIALS		TOTAL
	NO/UN	UNIT	MH UN	HRS	UN PRICE	COST	UN PRICE	COST	COST
						0.00		0.00	0
						0.00		0.00	0
9'X 30' HOOD	30	LF			44.50	1335.00	500.00	15000.00	16335
COMB. SUPPLY EXHAUST UNIT	27	MCFM			56.00	1512.00	310.00	8370.00	9882
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
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						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
SUBTOTAL						$2,847		$23,370	$26,217
OVERHEAD & PROFIT	10.00%								$2,622
TOTAL									$28,839

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 0407 – ECO IV. F.) – INSTALL MAKE–UP AIR SUPPLY FOR KITCHEN AREAS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 20 PREPARER C. M. JOHNSON

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$28,839		
B. SIOH	$1,586		
C. DESIGN COST	$1,730		
D. TOTAL COST (1A+1B+1C)	$32,155		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$32,155

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	92.89	$980	14.65	$14,357
B. DIST			$0	17.70	$0
C. RESID			$0	20.99	$0
D. NG	$3.31	249.67	$826	20.60	$17,024
E. PPG			$0	13.59	$0
F. COAL			$0	16.32	$0
G. SOLAR			$0	13.59	$0
H. GEOTH			$0	13.59	$0
I. BIOMA			$0	13.59	$0
J. REFUS			$0	13.59	$0
K. WIND			$0	13.59	$0
L. OTHER			$0	13.59	$0
M. DEMAND SAVINGS			$0	13.59	$0
N. TOTAL		342.56	$1,806		$31,381

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$0		
1. DISCOUNT FACTOR (TABLE A)			
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$0

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(–)

	ITEM	SAVINGS(+) COST(–)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV–INGS(+)COST(–)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $0

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 17.8 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $31,381

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 0.98

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 3.9%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's)

BUILDING NO. 407

ECO NO: IV.F (Hood 2)

ECO NAME: Install make-up air supply for kitchen areas

SUMMARY DATA (DEPENDENT):

KWH Savings:	3,217	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	28.61	MCF/yr
Cost Savings:	$ 213	/yr
Implementation Cost:	$ 7,419	
Simple Payback:	34.8	Years
Savings to Investment: Ratio (SIR):	.50	

ECO DESCRIPTION:

Currently, the kitchen hoods in use do not contain supply air make-up. This ECO analyzes the addition of make-up air supply for the kitchen hoods.

COST SAVINGS CALCULATIONS:

(Refer to following spreadsheet)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

MODIFIED BIN METHOD CALCULATIONS

REFER TO ASHRAE 1993 FUNDAMENTALS

BLDG. NO.				44	368	407	1350	1387	1462	2399	2652
TIME OF OPERATION				6:00A 1:30P	6:00A 2:00P	7A–10P 7A–2P	4:00A 8:30P	10:00A 9:00P	9A–8:30P 9A–10:30P	5:00A 7:30P	10:00A 7:00P
DAYS/WEEK				5	5	4 , 3	6	5	5 , 2	7	4
DB RANGE	MID PT.	MC WB	HUMID RATIO	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.
100/104	102	74	0.0116	6.4	7.0	14.6	14.5	10.1	15.8	16.1	7.1
95/99	97	74	0.0126	59.4	64.8	139.8	139.4	97.9	152.8	153.4	67.7
90/94	92	74	0.0139	135.0	147.3	309.0	307.1	213.4	334.4	339.8	149.6
85/89	87	73	0.0143	173.8	189.6	418.5	418.7	296.3	461.3	458.6	202.9
80/84	82	72	0.0146	213.2	231.4	530.6	557.5	382.4	589.7	595.6	253.5
75/79	77	70	0.0142	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70/74	72	66	0.0123	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65/69	67	61	0.0101	196.1	208.4	418.7	527.9	283.1	433.6	535.7	183.2
60/64	62	56	0.0082	161.8	172.0	346.9	437.0	235.1	359.9	443.3	151.9
55/59	57	51	0.0066	132.3	140.5	288.0	363.6	196.9	300.7	367.8	126.2
50/54	52	47	0.0057	118.4	125.4	256.0	332.4	174.6	265.8	333.0	110.6
45/49	47	43	0.0050	92.0	96.8	190.1	260.7	127.1	192.8	257.6	79.5
40/44	42	38	0.0039	72.4	75.9	138.6	198.4	88.8	135.1	195.0	56.1
35/39	37	34	0.0034	44.4	46.1	75.5	120.8	44.9	68.1	116.1	28.1
30/34	32	29	0.0028	23.0	23.8	34.9	60.3	18.9	28.8	57.4	12.0
25/29	27	25	0.0023	8.3	8.4	9.6	21.3	3.8	5.8	19.4	2.4
20/24	22	20	0.0016	2.4	2.5	3.6	6.1	2.0	3.0	5.9	1.3
15/19	17	15	0.0013	0.4	0.4	0.3	0.9	0.0	0.0	0.8	0.0
10/14	12	10	0.0009	0.2	0.2	0.1	0.4	0.0	0.0	0.4	0.0

ASSUMPTIONS

1) SUMMER ROOM DESIGN: 78FDB, 50%RH
2) WINTER ROOM DESIGN: 70FDB, 40%RH
3) HUMIDITY RATIOS FOR THE SPACE BASED ON SUMMER & WINTER ROOM DESIGN TEMP.

EQUIPMENT:

SMALL AIR COOLED CHILLER (3–25 TONS): 8.57 BTU/WATT–H
LARGE AIR COOLED CHILLER (25–100 TONS): 8.63 BTU/WATT–H
SMALL WATER COOLED CHILLER (25–100 TONS): 11.11 BTU/WATT–H
LARGE WATER COOLED CHILLER (>100 TONS): 12.12 BTU/WATT–H

SYSTEM TYPES FOR ABOVE BUILDINGS

BUILDING NUMBER	SYSTEM TYPE
44	SMALL AIR COOLED
368	SMALL AIR COOLED
407	LARGE AIR COOLED
1350	LARGE WATER COOLED
1387	SMALL AIR COOLED
1462	LARGE AIR COOLED
2399	LARGE WATER COOLED
2652	LARGE AIR COOLED

ASSUME 30% CONDITIONED AIR IS EXHAUSTED
EXHAUST CFM=4FTx8FTx100FPM=3200CFM
BUILDING 407

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
960	102	78	0.0116	0.0102	24883	6505	31388	14.6	458491
960	97	78	0.0126	0.0102	19699	11151	30851	139.8	4311366
960	92	78	0.0139	0.0102	14515	17192	31707	309.0	9796294
960	87	78	0.0143	0.0102	9331	19050	28381	418.5	11877633
960	82	78	0.0146	0.0102	4147	20444	24591	530.6	13047473
960	67	70	0.0101	0.0062	3110	18121	21231	418.7	8888736
960	62	70	0.0082	0.0062	8294	9293	17587	346.9	6100560
960	57	70	0.0066	0.0062	13478	1859	15337	288.0	4417592
960	52	70	0.0057	0.0062	18662	2323	20986	256.0	5371564
960	47	70	0.0050	0.0062	23846	5576	29422	190.1	5593348
960	42	70	0.0039	0.0062	29030	10687	39717	138.6	5505077
960	37	70	0.0034	0.0062	34214	13010	47224	75.5	3565436
960	32	70	0.0027	0.0062	39398	16262	55661	34.9	1940176
960	27	70	0.0023	0.0062	44582	18121	62703	9.6	600161
960	22	70	0.0017	0.0062	49766	20909	70675	3.6	257460
960	17	70	0.0013	0.0062	54950	22767	77718	0.3	19429
960	12	70	0.0009	0.0062	60134	24626	84760	0.1	10595

TOTAL COOLING KBTU FOR THE YEAR 39491
TOTAL HEATING KBTU FOR THE YEAR 42270
EQUIPMENT 8.63 BTU/WATT-HR COOLING KWH 4608

NOW 30% OF THE 960 CFM IS EXHAUSTED
EXHAUST CFM=4FTx8FTx100FPM=3200CFM
BUILDING 407

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
290	102	78	0.0116	0.0102	7517	1965	9482	14.6	138503
290	97	78	0.0126	0.0102	5951	3369	9319	139.8	1302392
290	92	78	0.0139	0.0102	4385	5193	9578	309.0	2959297
290	87	78	0.0143	0.0102	2819	5755	8574	418.5	3588035
290	82	78	0.0146	0.0102	1253	6176	7429	530.6	3941424
290	67	70	0.0101	0.0062	940	5474	6414	418.7	2685139
290	62	70	0.0082	0.0062	2506	2807	5313	346.9	1842878
290	57	70	0.0066	0.0062	4072	561	4633	288.0	1334481
290	52	70	0.0057	0.0062	5638	702	6339	256.0	1622660
290	47	70	0.0050	0.0062	7204	1684	8888	190.1	1689657
290	42	70	0.0039	0.0062	8770	3228	11998	138.6	1662992
290	37	70	0.0034	0.0062	10336	3930	14266	75.5	1077059
290	32	70	0.0027	0.0062	11902	4913	16814	34.9	586095
290	27	70	0.0023	0.0062	13468	5474	18942	9.6	181299
290	22	70	0.0017	0.0062	15034	6316	21350	3.6	77774
290	17	70	0.0013	0.0062	16600	6878	23477	0.3	5869
290	12	70	0.0009	0.0062	18166	7439	25605	0.1	3201

TOTAL COOLING KBTU FOR THE YEAR 11930
TOTAL HEATING KBTU FOR THE YEAR 12769
EQUIPMENT 8.63 BTU/WATT-HR COOLING KWH 1392

CARTER & BURGESS COST ESTIMATING ANALYSIS

PROJECT NAME: FORT SAM HOUSTON EEAP	PROJECT NO: 91109912F
PROJECT LOCATION: SAN ANTONIO, TEXAS	ESTIMATOR: C.M. JOHNSON
SUBMITTAL: 35.0%	DATE: 27-Oct-93
ECO NO/BUILDING:IV. F./BLDG 407 HOOD 2	CHECKED BY: SPC

TASK DESCRIPTION	QUANTITY		LABOR				MATERIALS		TOTAL
	NO/UN	UNIT	MH UN	HRS	UN PRICE	COST	UN PRICE	COST	COST
						0.00		0.00	0
						0.00		0.00	0
4'X 8' HOOD	8	LF			44.50	356.00	400.00	3200.00	3556
COMB. SUPPLY EXHAUST UNIT	3.2	MCFM			119.00	380.80	660.00	2112.00	2493
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
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						0.00		0.00	0
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						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
SUBTOTAL						$737		$5,312	$6,049
OVERHEAD & PROFIT	10.00%								$605
TOTAL									$6,654

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 0407 – ECO IV. F.) – INSTALL MAKE–UP AIR SUPPLY FOR KITCHEN AREAS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 20 PREPARER C. M. JOHNSON

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$6,654		
B. SIOH	$366		
C. DESIGN COST	$399		
D. TOTAL COST (1A+1B+1C)	$7,419		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$7,419

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	10.98	$116	14.65	$1,697
B. DIST			$0	17.70	$0
C. RESID			$0	20.99	$0
D. NG	$3.31	29.50	$98	20.60	$2,011
E. PPG			$0	13.59	$0
F. COAL			$0	16.32	$0
G. SOLAR			$0	13.59	$0
H. GEOTH			$0	13.59	$0
I. BIOMA			$0	13.59	$0
J. REFUS			$0	13.59	$0
K. WIND			$0	13.59	$0
L. OTHER			$0	13.59	$0
M. DEMAND SAVINGS			$0	13.59	$0
N. TOTAL		40.48	$213		$3,709

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$0		
1. DISCOUNT FACTOR (TABLE A)			
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$0

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(-)

	ITEM	SAVINGS(+) COST(-)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV-INGS(+)COST(-)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $0

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 34.8 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $3,709

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 0.50

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 0.5%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's)

BUILDING NO. 407

ECO NO: IV.F (Hood 3)

ECO NAME: Install make-up air supply for kitchen areas

SUMMARY DATA (DEPENDENT):

KWH Savings:	2,016	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	17.9	MCF/yr
Cost Savings:	$ 134	/yr
Implementation Cost:	$ 3,577	
Simple Payback:	26.7	Years
Savings to Investment: Ratio (SIR):	.65	

ECO DESCRIPTION:

Currently, the kitchen hoods in use do not contain supply air make-up. This ECO analyzes the addition of make-up air supply for the kitchen hoods.

COST SAVINGS CALCULATIONS:

(Refer to following spreadsheet)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

MODIFIED BIN METHOD CALCULATIONS

REFER TO ASHRAE 1993 FUNDAMENTALS

BLDG. NO.				44	368	407	1350	1387	1462	2399	2652
TIME OF OPERATION				6:00A 1:30P	6:00A 2:00P	7A-10P 7A-2P	4:00A 8:30P	10:00A 9:00P	9A-8:30P 9A-10:30P	5:00A 7:30P	10:00A 7:00P
DAYS/WEEK				5	5	4 , 3	6	5	5 , 2	7	4
DB RANGE	MID PT.	MC WB	HUMID RATIO	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.
100/104	102	74	0.0116	6.4	7.0	14.6	14.5	10.1	15.8	16.1	7.1
95/99	97	74	0.0126	59.4	64.8	139.8	139.4	97.9	152.8	153.4	67.7
90/94	92	74	0.0139	135.0	147.3	309.0	307.1	213.4	334.4	339.8	149.6
85/89	87	73	0.0143	173.8	189.6	418.5	418.7	296.3	461.3	458.6	202.9
80/84	82	72	0.0146	213.2	231.4	530.6	557.5	382.4	589.7	595.6	253.5
75/79	77	70	0.0142	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70/74	72	66	0.0123	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65/69	67	61	0.0101	196.1	208.4	418.7	527.9	283.1	433.6	535.7	183.2
60/64	62	56	0.0082	161.8	172.0	346.9	437.0	235.1	359.9	443.3	151.9
55/59	57	51	0.0066	132.3	140.5	288.0	363.6	196.9	300.7	367.8	126.2
50/54	52	47	0.0057	118.4	125.4	256.0	332.4	174.6	265.8	333.0	110.6
45/49	47	43	0.0050	92.0	96.8	190.1	260.7	127.1	192.8	257.6	79.5
40/44	42	38	0.0039	72.4	75.9	138.6	198.4	88.8	135.1	195.0	56.1
35/39	37	34	0.0034	44.4	46.1	75.5	120.8	44.9	68.1	116.1	28.1
30/34	32	29	0.0028	23.0	23.8	34.9	60.3	18.9	28.8	57.4	12.0
25/29	27	25	0.0023	8.3	8.4	9.6	21.3	3.8	5.8	19.4	2.4
20/24	22	20	0.0016	2.4	2.5	3.6	6.1	2.0	3.0	5.9	1.3
15/19	17	15	0.0013	0.4	0.4	0.3	0.9	0.0	0.0	0.8	0.0
10/14	12	10	0.0009	0.2	0.2	0.1	0.4	0.0	0.0	0.4	0.0

ASSUMPTIONS

1) SUMMER ROOM DESIGN: 78FDB, 50%RH
2) WINTER ROOM DESIGN: 70FDB, 40%RH
3) HUMIDITY RATIOS FOR THE SPACE BASED ON SUMMER & WINTER ROOM DESIGN TEMP.

EQUIPMENT:

SMALL AIR COOLED CHILLER (3-25 TONS): 8.57 BTU/WATT-H
LARGE AIR COOLED CHILLER (25-100 TONS): 8.63 BTU/WATT-H
SMALL WATER COOLED CHILLER (25-100 TONS): 11.11 BTU/WATT-H
LARGE WATER COOLED CHILLER (>100 TONS): 12.12 BTU/WATT-H

SYSTEM TYPES FOR ABOVE BUILDINGS

BUILDING NUMBER	SYSTEM TYPE
44	SMALL AIR COOLED
368	SMALL AIR COOLED
407	LARGE AIR COOLED
1350	LARGE WATER COOLED
1387	SMALL AIR COOLED
1462	LARGE AIR COOLED
2399	LARGE WATER COOLED
2652	LARGE AIR COOLED

ASSUME 100% CONDITIONED AIR IS EXHAUSTED
EXHAUST CFM=6FTx1FTx100FPM=600CFM
BUILDING 407

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
600	102	78	0.0116	0.0102	15552	4066	19618	14.6	286557
600	97	78	0.0126	0.0102	12312	6970	19282	139.8	2694604
600	92	78	0.0139	0.0102	9072	10745	19817	309.0	6122683
600	87	78	0.0143	0.0102	5832	11906	17738	418.5	7423520
600	82	78	0.0146	0.0102	2592	12778	15370	530.6	8154671
600	67	70	0.0101	0.0062	1944	11326	13270	418.7	5555460
600	62	70	0.0082	0.0062	5184	5808	10992	346.9	3812850
600	57	70	0.0066	0.0062	8424	1162	9586	288.0	2760995
600	52	70	0.0057	0.0062	11664	1452	13116	256.0	3357228
600	47	70	0.0050	0.0062	14904	3485	18389	190.1	3495842
600	42	70	0.0039	0.0062	18144	6679	24823	138.6	3440673
600	37	70	0.0034	0.0062	21384	8131	29515	75.5	2228398
600	32	70	0.0027	0.0062	24624	10164	34788	34.9	1212610
600	27	70	0.0023	0.0062	27864	11326	39190	9.6	375100
600	22	70	0.0017	0.0062	31104	13068	44172	3.6	160912
600	17	70	0.0013	0.0062	34344	14230	48574	0.3	12143
600	12	70	0.0009	0.0062	37584	15391	52975	0.1	6622

TOTAL COOLING KBTU FOR THE YEAR 24682
TOTAL HEATING KBTU FOR THE YEAR 26419
EQUIPMENT 8.63 BTU/WATT–HR COOLING KWH 2860

NOW 30% CONDITIONED AIR IS EXHAUSTED
EXHAUST CFM=6FTx1FTx100FPM=600CFM
BUILDING 407

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
180	102	78	0.0116	0.0102	4666	1220	5885	14.6	85967
180	97	78	0.0126	0.0102	3694	2091	5784	139.8	808381
180	92	78	0.0139	0.0102	2722	3223	5945	309.0	1836805
180	87	78	0.0143	0.0102	1750	3572	5322	418.5	2227056
180	82	78	0.0146	0.0102	778	3833	4611	530.6	2446401
180	67	70	0.0101	0.0062	583	3398	3981	418.7	1666638
180	62	70	0.0082	0.0062	1555	1742	3298	346.9	1143855
180	57	70	0.0066	0.0062	2527	348	2876	288.0	828299
180	52	70	0.0057	0.0062	3499	436	3935	256.0	1007168
180	47	70	0.0050	0.0062	4471	1045	5517	190.1	1048753
180	42	70	0.0039	0.0062	5443	2004	7447	138.6	1032202
180	37	70	0.0034	0.0062	6415	2439	8855	75.5	668519
180	32	70	0.0027	0.0062	7387	3049	10436	34.9	363783
180	27	70	0.0023	0.0062	8359	3398	11757	9.6	112530
180	22	70	0.0017	0.0062	9331	3920	13252	3.6	48274
180	17	70	0.0013	0.0062	10303	4269	14572	0.3	3643
180	12	70	0.0009	0.0062	11275	4617	15893	0.1	1987

TOTAL COOLING KBTU FOR THE YEAR 7405
TOTAL HEATING KBTU FOR THE YEAR 7926
EQUIPMENT 8.63 BTU/WATT–HR COOLING KWH 864

CARTER & BURGESS COST ESTIMATING ANALYSIS

PROJECT NAME: FORT SAM HOUSTON EEAP	PROJECT NO: 91109912F
PROJECT LOCATION: SAN ANTONIO, TEXAS	ESTIMATOR: C.M. JOHNSON
SUBMITTAL: 35.0%	DATE: 27-Oct-93
ECO NO/BUILDING:IV. F./BLDG 407 HOOD 3	CHECKED BY: SPC

TASK DESCRIPTION	QUANTITY		LABOR				MATERIALS		TOTAL COST
	NO/UN	UNIT	MH UN	HRS	UN PRICE	COST	UN PRICE	COST	
						0.00		0.00	0
						0.00		0.00	0
1'X 6' HOOD	6	LF			44.50	267.00	350.00	2100.00	2367
COMB. SUPPLY EXHAUST UNIT	0.6	MCFM			140.00	84.00	775.00	465.00	549
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
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						0.00		0.00	0
						0.00		0.00	0
SUBTOTAL						$351		$2,565	$2,916
OVERHEAD & PROFIT	10.00%								$292
TOTAL									$3,208

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 0407 – ECO IV. F.) – INSTALL MAKE–UP AIR SUPPLY FOR KITCHEN AREAS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 20 PREPARER C. M. JOHNSON

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$3,208		
B. SIOH	$176		
C. DESIGN COST	$192		
D. TOTAL COST (1A+1B+1C)	$3,577		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$3,577

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	6.88	$73	14.65	$1,063
B. DIST			$0	17.70	$0
C. RESID			$0	20.99	$0
D. NG	$3.31	18.49	$61	20.60	$1,261
E. PPG			$0	13.59	$0
F. COAL			$0	16.32	$0
G. SOLAR			$0	13.59	$0
H. GEOTH			$0	13.59	$0
I. BIOMA			$0	13.59	$0
J. REFUS			$0	13.59	$0
K. WIND			$0	13.59	$0
L. OTHER			$0	13.59	$0
M. DEMAND SAVINGS			$0	13.59	$0
N. TOTAL		25.37	$134		$2,324

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$0		
1. DISCOUNT FACTOR (TABLE A)			
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$0

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(-)

	ITEM	SAVINGS(+) COST(-)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV-INGS(+)COST(-)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $0

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 26.7 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $2,324

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 0.65

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 1.8%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's)

BUILDING NO. 407

ECO NO: XI.A.

ECO NAME: Replace boilers with 99% efficient boilers.

SUMMARY DATA (DEPENDENT):

KWH Savings:	0	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	95.8	MCF/yr
Cost Savings:	$ 327	/yr
Implementation Cost:	$ 34,280	
Simple Payback:	104.8	Years

ECO DESCRIPTION:

This ECO analyzes replacing the existing domestic hot water boilers with 99% efficient boilers.

COST SAVINGS CALCULATIONS:

(Refer to following SimpCalc output)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

Form	Facility	ECRM Desc.	Page	KWH/Yr	KW	MCF/yr	mmBtu/Yr	$/Yr	Imp.Cost	PayBack
C9-01	BLDG 0407 OFFICERS CLUB	Low Eff Hot Wat	24	0	.00	95.8	98.7	327	34280	104.8
		*** SUB-TOTAL ***		0	.00	95.8	98.7	327	34280	104.8
	** GRAND TOTAL **			0	.00	95.8	98.7	327	34280	104.8

C9-001 Replace Low Efficiency DHW Units - BLDG 0407 OFFICERS CLUB (G)

Cost Source: vender quote

Description: Install high efficiency water heater.

A)	2.40	Gal/person	Daily Hot Water Consumption per Capita (Table 10)
B)	286	People	Number of People in Facility
C)	365	Days	Days per Year of Occupancy
D)	140	Degree/F	Hot Water Temperature
E)	.7000		Heating Efficiency Existing
F)	.9900		Heating Efficiency Proposed
G)	45.70	mmBTU/yr	Standby Loss for Gas Water Heater
H)	.40		Reduction in Standby Loss
I) $	3.41	/MCF	Cost per MCF
J) $	34280	/Unit	Installed Cost of Replacement Unit
K)	146.1	mmBTU/yr	Annual BTU's for Hot Water
L)	266.0	MCF/year	Existing Unit Consumption
M)	170.2	MCF/year	Proposed Unit Consumption
N)	95.8	MCF/year	Total Consumption Savings
O) $	327	/year	Annual Cost Savings
P)	104.8	years	Simple Payback

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's)

BUILDING NO. 1350

ECO NO: IV.F (Hood 1)

ECO NAME: Install make-up air supply for kitchen areas

SUMMARY DATA (DEPENDENT):

KWH Savings:	5,115.7	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	61.5	MCF/yr
Cost Savings:	$ 394	/yr
Implementation Cost:	$ 4,410	
Simple Payback:	11.2	Years
Savings to Investment: Ratio (SIR):	1.59	

ECO DESCRIPTION:

Currently, the kitchen hoods in use do not contain supply air make-up. This ECO analyzes the addition of make-up air supply for the kitchen hoods.

COST SAVINGS CALCULATIONS:

(Refer to following spreadsheet)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

MODIFIED BIN METHOD CALCULATIONS

REFER TO ASHRAE 1993 FUNDAMENTALS

BLDG. NO.				44	368	407	1350	1387	1462	2399	2652
TIME OF OPERATION				6:00A 1:30P	6:00A 2:00P	7A-10P 7A-2P	4:00A 8:30P	10:00A 9:00P	9A-8:30P 9A-10:30P	5:00A 7:30P	10:00A 7:00P
DAYS/WEEK				5	5	4 , 3	6	5	5 , 2	7	4
DB RANGE	MID PT.	MC WB	HUMID RATIO	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.
100/104	102	74	0.0116	6.4	7.0	14.6	14.5	10.1	15.8	16.1	7.1
95/99	97	74	0.0126	59.4	64.8	139.8	139.4	97.9	152.8	153.4	67.7
90/94	92	74	0.0139	135.0	147.3	309.0	307.1	213.4	334.4	339.8	149.6
85/89	87	73	0.0143	173.8	189.6	418.5	418.7	296.3	461.3	458.6	202.9
80/84	82	72	0.0146	213.2	231.4	530.6	557.5	382.4	589.7	595.6	253.5
75/79	77	70	0.0142	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70/74	72	66	0.0123	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65/69	67	61	0.0101	196.1	208.4	418.7	527.9	283.1	433.6	535.7	183.2
60/64	62	56	0.0082	161.8	172.0	346.9	437.0	235.1	359.9	443.3	151.9
55/59	57	51	0.0066	132.3	140.5	288.0	363.6	196.9	300.7	367.8	126.2
50/54	52	47	0.0057	118.4	125.4	256.0	332.4	174.6	265.8	333.0	110.6
45/49	47	43	0.0050	92.0	96.8	190.1	260.7	127.1	192.8	257.6	79.5
40/44	42	38	0.0039	72.4	75.9	138.6	198.4	88.8	135.1	195.0	56.1
35/39	37	34	0.0034	44.4	46.1	75.5	120.8	44.9	68.1	116.1	28.1
30/34	32	29	0.0028	23.0	23.8	34.9	60.3	18.9	28.8	57.4	12.0
25/29	27	25	0.0023	8.3	8.4	9.6	21.3	3.8	5.8	19.4	2.4
20/24	22	20	0.0016	2.4	2.5	3.6	6.1	2.0	3.0	5.9	1.3
15/19	17	15	0.0013	0.4	0.4	0.3	0.9	0.0	0.0	0.8	0.0
10/14	12	10	0.0009	0.2	0.2	0.1	0.4	0.0	0.0	0.4	0.0

ASSUMPTIONS

1) SUMMER ROOM DESIGN: 78FDB, 50%RH
2) WINTER ROOM DESIGN: 70FDB, 40%RH
3) HUMIDITY RATIOS FOR THE SPACE BASED ON SUMMER & WINTER ROOM DESIGN TEMP.

EQUIPMENT:
SMALL AIR COOLED CHILLER (3-25 TONS): 8.57 BTU/WATT-H
LARGE AIR COOLED CHILLER (25-100 TONS): 8.63 BTU/WATT-H
SMALL WATER COOLED CHILLER (25-100 TONS): 11.11 BTU/WATT-H
LARGE WATER COOLED CHILLER (>100 TONS): 12.12 BTU/WATT-H

SYSTEM TYPES FOR ABOVE BUILDINGS

BUILDING NUMBER	SYSTEM TYPE
44	SMALL AIR COOLED
368	SMALL AIR COOLED
407	LARGE AIR COOLED
1350	LARGE WATER COOLED
1387	SMALL AIR COOLED
1462	LARGE AIR COOLED
2399	LARGE WATER COOLED
2652	LARGE AIR COOLED

ASSUME 100% CONDITIONED AIR IS EXHAUSTED
EXHAUST CFM=3FTx5FTx100FPM=1500CFM
BUILDING 1350

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
1500	102	78	0.0116	0.0102	38880	10164	49044	14.5	712014
1500	97	78	0.0126	0.0102	30780	17424	48204	139.4	6719293
1500	92	78	0.0139	0.0102	22680	26862	49542	307.1	15212933
1500	87	78	0.0143	0.0102	14580	29766	44346	418.7	18565928
1500	82	78	0.0146	0.0102	6480	31944	38424	557.5	21422066
1500	67	70	0.0101	0.0062	4860	28314	33174	527.9	17514095
1500	62	70	0.0082	0.0062	12960	14520	27480	437.0	12008269
1500	57	70	0.0066	0.0062	21060	2904	23964	363.6	8713054
1500	52	70	0.0057	0.0062	29160	3630	32790	332.4	10897991
1500	47	70	0.0050	0.0062	37260	8712	45972	260.7	11986378
1500	42	70	0.0039	0.0062	45360	16698	62058	198.4	12314080
1500	37	70	0.0034	0.0062	53460	20328	73788	120.8	8913854
1500	32	70	0.0027	0.0062	61560	25410	86970	60.3	5246155
1500	27	70	0.0023	0.0062	69660	28314	97974	21.3	2083697
1500	22	70	0.0017	0.0062	77760	32670	110430	6.1	674412
1500	17	70	0.0013	0.0062	85860	35574	121434	0.9	104086
1500	12	70	0.0009	0.0062	93960	38478	132438	0.4	56759
					TOTAL COOLING KBTU FOR THE YEAR				62632
					TOTAL HEATING KBTU FOR THE YEAR				90513
					EQUIPMENT 12.12 BTU/WATT-HR COOLING KWH				7308

NOW 30% CONDITIONED AIR IS EXHAUSTED
EXHAUST CFM=3FTx5FTx100FPM=1500CFM
BUILDING 1350

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
450	102	78	0.0116	0.0102	11664	3049	14713	14.5	213604
450	97	78	0.0126	0.0102	9234	5227	14461	139.4	2015788
450	92	78	0.0139	0.0102	6804	8059	14863	307.1	4563880
450	87	78	0.0143	0.0102	4374	8930	13304	418.7	5569778
450	82	78	0.0146	0.0102	1944	9583	11527	557.5	6426620
450	67	70	0.0101	0.0062	1458	8494	9952	527.9	5254228
450	62	70	0.0082	0.0062	3888	4356	8244	437.0	3602481
450	57	70	0.0066	0.0062	6318	871	7189	363.6	2613916
450	52	70	0.0057	0.0062	8748	1089	9837	332.4	3269397
450	47	70	0.0050	0.0062	11178	2614	13792	260.7	3595913
450	42	70	0.0039	0.0062	13608	5009	18617	198.4	3694224
450	37	70	0.0034	0.0062	16038	6098	22136	120.8	2674156
450	32	70	0.0027	0.0062	18468	7623	26091	60.3	1573846
450	27	70	0.0023	0.0062	20898	8494	29392	21.3	625109
450	22	70	0.0017	0.0062	23328	9801	33129	6.1	202324
450	17	70	0.0013	0.0062	25758	10672	36430	0.9	31226
450	12	70	0.0009	0.0062	28188	11543	39731	0.4	17028
					TOTAL COOLING KBTU FOR THE YEAR				18790
					TOTAL HEATING KBTU FOR THE YEAR				27154
					EQUIPMENT 12.12 BTU/WATT-HR COOLING KWH				2192

CARTER & BURGESS COST ESTIMATING ANALYSIS

PROJECT NAME: FORT SAM HOUSTON EEAP	PROJECT NO: 91109912F
PROJECT LOCATION: SAN ANTONIO, TEXAS	ESTIMATOR: C.M. JOHNSON
SUBMITTAL: 35.0%	DATE: 27-Oct-93
ECO NO/BUILDING:IV. F./BLDG 1350 HOOD 1	CHECKED BY: SPC

TASK DESCRIPTION	QUANTITY		LABOR				MATERIALS		TOTAL
	NO/UN	UNIT	MH UN	HRS	UN PRICE	COST	UN PRICE	COST	COST
						0.00		0.00	0
						0.00		0.00	0
3'X 5' HOOD	5	LF			44.50	222.50	400.00	2000.00	2223
COMB. SUPPLY EXHAUST UNIT	1.5	MCFM			140.00	210.00	775.00	1162.50	1373
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
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						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
SUBTOTAL						$433		$3,163	$3,595
OVERHEAD & PROFIT	10.00%								$360
TOTAL									$3,955

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 1350 – ECO IV. F.) – INSTALL MAKE-UP AIR SUPPLY FOR KITCHEN AREAS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 20 PREPARER C. M. JOHNSON

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$3,955		
B. SIOH	$218		
C. DESIGN COST	$237		
D. TOTAL COST (1A+1B+1C)	$4,410		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$4,410

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	17.46	$184	14.65	$2,699
B. DIST			$0	17.70	$0
C. RESID			$0	20.99	$0
D. NG	$3.31	63.36	$210	20.60	$4,320
E. PPG			$0	13.59	$0
F. COAL			$0	16.32	$0
G. SOLAR			$0	13.59	$0
H. GEOTH			$0	13.59	$0
I. BIOMA			$0	13.59	$0
J. REFUS			$0	13.59	$0
K. WIND			$0	13.59	$0
L. OTHER			$0	13.59	$0
M. DEMAND SAVINGS			$0	13.59	$0
N. TOTAL		80.82	$394		$7,019

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$0		
1. DISCOUNT FACTOR (TABLE A)			
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$0

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV−INGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $0

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 11.2 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $7,019

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 1.59

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 6.4%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's)

BUILDING NO. 1350

ECO NO: XI.A.

ECO NAME: Replace boilers with 99% efficient boiler.

SUMMARY DATA (DEPENDENT):

KWH Savings:	0	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	271.8	MCF/yr
Cost Savings:	$ 927	/yr
Implementation Cost:	$ 34,280	
Simple Payback:	37.0	Years

ECO DESCRIPTION:

This ECO analyzes replacing the existing domestic hot water boilers with 99% efficient boilers.

COST SAVINGS CALCULATIONS:

(Refer to following SimpCalc output)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

Form	Facility	ECRM Desc.	Page	KWH/Yr	KW	MCF/yr	mmBtu/Yr	$/Yr	Imp.Cost	PayBack
C9-01	BLDG 1350 DINING FACILITY	Low Eff Hot Wat	25	0	.00	271.8	280.0	927	34280	37.0
		*** SUB-TOTAL ***		0	.00	271.8	280.0	927	34280	37.0
	** GRAND TOTAL **			0	.00	271.8	280.0	927	34280	37.0

C9-001 Replace Low Efficiency DHW Units - BLDG 1350 DINING FACILITY (G)

Cost Source: vender quote

Description: Install high efficiency hot water heaters.

A)	7.20	Gal/person	Daily Hot Water Consumption per Capita (Table 10)
B)	498	People	Number of People in Facility
C)	365	Days	Days per Year of Occupancy
D)	140	Degree/F	Hot Water Temperature
E)	.7500		Heating Efficiency Existing
F)	.9900		Heating Efficiency Proposed
G)	45.70	mmBTU/yr	Standby Loss for Gas Water Heater
H)	.40		Reduction in Standby Loss
I)	$ 3.41	/MCF	Cost per MCF
J)	$ 34280	/Unit	Installed Cost of Replacement Unit
K)	763.1	mmBTU/yr	Annual BTU's for Hot Water
L)	1047.0	MCF/year	Existing Unit Consumption
M)	775.2	MCF/year	Proposed Unit Consumption
N)	271.8	MCF/year	Total Consumption Savings
O)	$ 927	/year	Annual Cost Savings
P)	37.0	years	Simple Payback

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's)

BUILDING NO. 1387

ECO NO: IV.F (Hood 1)

ECO NAME: Install make-up air supply for kitchen areas

SUMMARY DATA (DEPENDENT):

KWH Savings:	5,702	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	46.9	MCF/yr
Cost Savings:	$ 365	/yr
Implementation Cost:	$ 5,964	
Simple Payback:	16.3	Years
Savings to Investment: Ratio (SIR):	1.06	

ECO DESCRIPTION:

Currently, the kitchen hoods in use do not contain supply air make-up. This ECO analyzes the addition of make-up air supply for the kitchen hoods.

COST SAVINGS CALCULATIONS:

(Refer to following spreadsheet)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

MODIFIED BIN METHOD CALCULATIONS

REFER TO ASHRAE 1993 FUNDAMENTALS

BLDG. NO.				44	368	407	1350	1387	1462	2399	2652
TIME OF OPERATION				6:00A 1:30P	6:00A 2:00P	7A-10P 7A-2P	4:00A 8:30P	10:00A 9:00P	9A-8:30P 9A-10:30P	5:00A 7:30P	10:00A 7:00P
DAYS/WEEK				5	5	4, 3	6	5	5, 2	7	4
DB RANGE	MID PT.	MC WB	HUMID RATIO	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.
100/104	102	74	0.0116	6.4	7.0	14.6	14.5	10.1	15.8	16.1	7.1
95/99	97	74	0.0126	59.4	64.8	139.8	139.4	97.9	152.8	153.4	67.7
90/94	92	74	0.0139	135.0	147.3	309.0	307.1	213.4	334.4	339.8	149.6
85/89	87	73	0.0143	173.8	189.6	418.5	418.7	296.3	461.3	458.6	202.9
80/84	82	72	0.0146	213.2	231.4	530.6	557.5	382.4	589.7	595.6	253.5
75/79	77	70	0.0142	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70/74	72	66	0.0123	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65/69	67	61	0.0101	196.1	208.4	418.7	527.9	283.1	433.6	535.7	183.2
60/64	62	56	0.0082	161.8	172.0	346.9	437.0	235.1	359.9	443.3	151.9
55/59	57	51	0.0066	132.3	140.5	288.0	363.6	196.9	300.7	367.8	126.2
50/54	52	47	0.0057	118.4	125.4	256.0	332.4	174.6	265.8	333.0	110.6
45/49	47	43	0.0050	92.0	96.8	190.1	260.7	127.1	192.8	257.6	79.5
40/44	42	38	0.0039	72.4	75.9	138.6	198.4	88.8	135.1	195.0	56.1
35/39	37	34	0.0034	44.4	46.1	75.5	120.8	44.9	68.1	116.1	28.1
30/34	32	29	0.0028	23.0	23.8	34.9	60.3	18.9	28.8	57.4	12.0
25/29	27	25	0.0023	8.3	8.4	9.6	21.3	3.8	5.8	19.4	2.4
20/24	22	20	0.0016	2.4	2.5	3.6	6.1	2.0	3.0	5.9	1.3
15/19	17	15	0.0013	0.4	0.4	0.3	0.9	0.0	0.0	0.8	0.0
10/14	12	10	0.0009	0.2	0.2	0.1	0.4	0.0	0.0	0.4	0.0

ASSUMPTIONS

1) SUMMER ROOM DESIGN: 78FDB, 50%RH
2) WINTER ROOM DESIGN: 70FDB, 40%RH
3) HUMIDITY RATIOS FOR THE SPACE BASED ON SUMMER & WINTER ROOM DESIGN TEMP.

EQUIPMENT:
SMALL AIR COOLED CHILLER (3-25 TONS): 8.57 BTU/WATT-H
LARGE AIR COOLED CHILLER (25-100 TONS): 8.63 BTU/WATT-H
SMALL WATER COOLED CHILLER (25-100 TONS): 11.11 BTU/WATT-H
LARGE WATER COOLED CHILLER (>100 TONS): 12.12 BTU/WATT-H

SYSTEM TYPES FOR ABOVE BUILDINGS

BUILDING NUMBER	SYSTEM TYPE
44	SMALL AIR COOLED
368	SMALL AIR COOLED
407	LARGE AIR COOLED
1350	LARGE WATER COOLED
1387	SMALL AIR COOLED
1462	LARGE AIR COOLED
2399	LARGE WATER COOLED
2652	LARGE AIR COOLED

ASSUME 100% CONDITIONED AIR IS EXHAUSTED
EXHAUST CFM=4FTx6FTx100FPM=2400CFM
BUILDING 1387

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
2400	102	78	0.0116	0.0102	62208	16262	78470	10.1	791710
2400	97	78	0.0126	0.0102	49248	27878	77126	97.9	7547369
2400	92	78	0.0139	0.0102	36288	42979	79267	213.4	16915054
2400	87	78	0.0143	0.0102	23328	47626	70954	296.3	21026339
2400	82	78	0.0146	0.0102	10368	51110	61478	382.4	23509999
2400	67	70	0.0101	0.0062	7776	45302	53078	283.1	15027822
2400	62	70	0.0082	0.0062	20736	23232	43968	235.1	10336406
2400	57	70	0.0066	0.0062	33696	4646	38342	196.9	7548660
2400	52	70	0.0057	0.0062	46656	5808	52464	174.6	9162463
2400	47	70	0.0050	0.0062	59616	13939	73555	127.1	9345451
2400	42	70	0.0039	0.0062	72576	26717	99293	88.8	8812236
2400	37	70	0.0034	0.0062	85536	32525	118061	44.9	5302195
2400	32	70	0.0027	0.0062	98496	40656	139152	18.9	2633949
2400	27	70	0.0023	0.0062	111456	45302	156758	3.8	601840
2400	22	70	0.0017	0.0062	124416	52272	176688	2.0	347066
2400	17	70	0.0013	0.0062	137376	56918	194294	0.0	0
2400	12	70	0.0009	0.0062	150336	61565	211901	0.0	0
					TOTAL COOLING KBTU FOR THE YEAR				69790
					TOTAL HEATING KBTU FOR THE YEAR				69118
			EQUIPMENT 8.57 BTU/WATT-HR			COOLING KWH			8144

NOW 30% CONDITIONED AIR IS EXHAUSTED
EXHAUST CFM=4FTx6FTx100FPM=2400CFM
BUILDING 1387

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
720	102	78	0.0116	0.0102	18662	4879	23541	10.1	237513
720	97	78	0.0126	0.0102	14774	8364	23138	97.9	2264211
720	92	78	0.0139	0.0102	10886	12894	23780	213.4	5074516
720	87	78	0.0143	0.0102	6998	14288	21286	296.3	6307902
720	82	78	0.0146	0.0102	3110	15333	18444	382.4	7053000
720	67	70	0.0101	0.0062	2333	13591	15924	283.1	4508347
720	62	70	0.0082	0.0062	6221	6970	13190	235.1	3100922
720	57	70	0.0066	0.0062	10109	1394	11503	196.9	2264598
720	52	70	0.0057	0.0062	13997	1742	15739	174.6	2748739
720	47	70	0.0050	0.0062	17885	4182	22067	127.1	2803635
720	42	70	0.0039	0.0062	21773	8015	29788	88.8	2643671
720	37	70	0.0034	0.0062	25661	9757	35418	44.9	1590658
720	32	70	0.0027	0.0062	29549	12197	41746	18.9	790185
720	27	70	0.0023	0.0062	33437	13591	47028	3.8	180552
720	22	70	0.0017	0.0062	37325	15682	53006	2.0	104120
720	17	70	0.0013	0.0062	41213	17076	58288	0.0	0
720	12	70	0.0009	0.0062	45101	18469	63570	0.0	0
					TOTAL COOLING KBTU FOR THE YEAR				20937
					TOTAL HEATING KBTU FOR THE YEAR				20735
			EQUIPMENT 8.57 BTU/WATT-HR			COOLING KWH			2443

CARTER & BURGESS COST ESTIMATING ANALYSIS

PROJECT NAME: FORT SAM HOUSTON EEAP	PROJECT NO: 91109912F
PROJECT LOCATION: SAN ANTONIO, TEXAS	ESTIMATOR: C.M. JOHNSON
SUBMITTAL: 35.0%	DATE: 27-Oct-93
ECO NO/BUILDING:IV. F./BLDG 1387 HOOD 1	CHECKED BY: SPC

TASK DESCRIPTION	QUANTITY		LABOR				MATERIALS		TOTAL COST
	NO/UN	UNIT	MH UN	HRS	UN PRICE	COST	UN PRICE	COST	
						0.00		0.00	0
						0.00		0.00	0
4'X 6' HOOD	6	LF			44.50	267.00	400.00	2400.00	2667
COMB. SUPPLY EXHAUST UNIT	2.4	MCFM			140.00	336.00	775.00	1860.00	2196
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
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						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
SUBTOTAL						$603		$4,260	$4,863
OVERHEAD & PROFIT	10.00%								$486
TOTAL									$5,349

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 1387 – ECO IV. F.) – INSTALL MAKE–UP AIR SUPPLY FOR KITCHEN AREAS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 20 PREPARER C. M. JOHNSON

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$5,349		
B. SIOH	$294		
C. DESIGN COST	$321		
D. TOTAL COST (1A+1B+1C)	$5,964		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$5,964

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	19.46	$205	14.65	$3,008
B. DIST			$0	17.70	$0
C. RESID			$0	20.99	$0
D. NG	$3.31	48.38	$160	20.60	$3,299
E. PPG			$0	13.59	$0
F. COAL			$0	16.32	$0
G. SOLAR			$0	13.59	$0
H. GEOTH			$0	13.59	$0
I. BIOMA			$0	13.59	$0
J. REFUS			$0	13.59	$0
K. WIND			$0	13.59	$0
L. OTHER			$0	13.59	$0
M. DEMAND SAVINGS			$0	13.59	$0
N. TOTAL		67.84	$365		$6,307

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$0		
1. DISCOUNT FACTOR (TABLE A)			
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$0

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(–)

	ITEM	SAVINGS(+) COST(–)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV– INGS(+)COST(–)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $0

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 16.3 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $6,307

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 1.06

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 4.3%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's)

BUILDING NO. 1387

ECO NO: IV.F (Hood 2)

ECO NAME: Install make-up air supply for kitchen areas

SUMMARY DATA (DEPENDENT):

KWH Savings:	8,737	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	71.9	MCF/yr
Cost Savings:	$ 560	/yr
Implementation Cost:	$ 9,260	
Simple Payback:	16.5	Years
Savings to Investment: Ratio (SIR):	1.04	

ECO DESCRIPTION:

Currently, the kitchen hoods in use do not contain supply air make-up. This ECO analyzes the addition of make-up air supply for the kitchen hoods.

COST SAVINGS CALCULATIONS:

(Refer to following spreadsheet)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

MODIFIED BIN METHOD CALCULATIONS

REFER TO ASHRAE 1993 FUNDAMENTALS

BLDG. NO.				44	368	407	1350	1387	1462	2399	2652
TIME OF OPERATION				6:00A 1:30P	6:00A 2:00P	7A-10P 7A-2P	4:00A 8:30P	10:00A 9:00P	9A-8:30P 9A-10:30P	5:00A 7:30P	10:00A 7:00P
DAYS/WEEK				5	5	4 , 3	6	5	5 , 2	7	4
DB RANGE	MID PT.	MC WB	HUMID RATIO	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.
100/104	102	74	0.0116	6.4	7.0	14.6	14.5	10.1	15.8	16.1	7.1
95/99	97	74	0.0126	59.4	64.8	139.8	139.4	97.9	152.8	153.4	67.7
90/94	92	74	0.0139	135.0	147.3	309.0	307.1	213.4	334.4	339.8	149.6
85/89	87	73	0.0143	173.8	189.6	418.5	418.7	296.3	461.3	458.6	202.9
80/84	82	72	0.0146	213.2	231.4	530.6	557.5	382.4	589.7	595.6	253.5
75/79	77	70	0.0142	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70/74	72	66	0.0123	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65/69	67	61	0.0101	196.1	208.4	418.7	527.9	283.1	433.6	535.7	183.2
60/64	62	56	0.0082	161.8	172.0	346.9	437.0	235.1	359.9	443.3	151.9
55/59	57	51	0.0066	132.3	140.5	288.0	363.6	196.9	300.7	367.8	126.2
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45/49	47	43	0.0050	92.0	96.8	190.1	260.7	127.1	192.8	257.6	79.5
40/44	42	38	0.0039	72.4	75.9	138.6	198.4	88.8	135.1	195.0	56.1
35/39	37	34	0.0034	44.4	46.1	75.5	120.8	44.9	68.1	116.1	28.1
30/34	32	29	0.0028	23.0	23.8	34.9	60.3	18.9	28.8	57.4	12.0
25/29	27	25	0.0023	8.3	8.4	9.6	21.3	3.8	5.8	19.4	2.4
20/24	22	20	0.0016	2.4	2.5	3.6	6.1	2.0	3.0	5.9	1.3
15/19	17	15	0.0013	0.4	0.4	0.3	0.9	0.0	0.0	0.8	0.0
10/14	12	10	0.0009	0.2	0.2	0.1	0.4	0.0	0.0	0.4	0.0

ASSUMPTIONS

1) SUMMER ROOM DESIGN: 78FDB, 50%RH
2) WINTER ROOM DESIGN: 70FDB, 40%RH
3) HUMIDITY RATIOS FOR THE SPACE BASED ON SUMMER & WINTER ROOM DESIGN TEMP.

EQUIPMENT:

SMALL AIR COOLED CHILLER (3-25 TONS): 8.57 BTU/WATT-H
LARGE AIR COOLED CHILLER (25-100 TONS): 8.63 BTU/WATT-H
SMALL WATER COOLED CHILLER (25-100 TONS): 11.11 BTU/WATT-H
LARGE WATER COOLED CHILLER (>100 TONS): 12.12 BTU/WATT-H

SYSTEM TYPES FOR ABOVE BUILDINGS

BUILDING NUMBER	SYSTEM TYPE
44	SMALL AIR COOLED
368	SMALL AIR COOLED
407	LARGE AIR COOLED
1350	LARGE WATER COOLED
1387	SMALL AIR COOLED
1462	LARGE AIR COOLED
2399	LARGE WATER COOLED
2652	LARGE AIR COOLED

ASSUME 100% CONDITIONED AIR IS EXHAUSTED
EXHAUST CFM=10.5FTx3.5FTx100FPM=3675CFM
BUILDING 1387

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
3675	102	78	0.0116	0.0102	95256	24902	120158	10.1	1212306
3675	97	78	0.0126	0.0102	75411	42689	118100	97.9	11556909
3675	92	78	0.0139	0.0102	55566	65812	121378	213.4	25901177
3675	87	78	0.0143	0.0102	35721	72927	108648	296.3	32196582
3675	82	78	0.0146	0.0102	15876	78263	94139	382.4	35999686
3675	67	70	0.0101	0.0062	11907	69369	81276	283.1	23011352
3675	62	70	0.0082	0.0062	31752	35574	67326	235.1	15827621
3675	57	70	0.0066	0.0062	51597	7115	58712	196.9	11558886
3675	52	70	0.0057	0.0062	71442	8893	80336	174.6	14030021
3675	47	70	0.0050	0.0062	91287	21344	112631	127.1	14310222
3675	42	70	0.0039	0.0062	111132	40910	152042	88.8	13493736
3675	37	70	0.0034	0.0062	130977	49804	180781	44.9	8118986
3675	32	70	0.0027	0.0062	150822	62254	213077	18.9	4033234
3675	27	70	0.0023	0.0062	170667	69369	240036	3.8	921568
3675	22	70	0.0017	0.0062	190512	80042	270554	2.0	531444
3675	17	70	0.0013	0.0062	210357	87156	297513	0.0	0
3675	12	70	0.0009	0.0062	230202	94271	324473	0.0	0

TOTAL COOLING KBTU FOR THE YEAR 106867
TOTAL HEATING KBTU FOR THE YEAR 105837
EQUIPMENT 8.57 BTU/WATT-HR COOLING KWH 12470

NOW 30% CONDITIONED AIR IS EXHAUSTED
EXHAUST CFM=10.5FTx3.5FTx100FPM=3675CFM
BUILDING 1387

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
1100	102	78	0.0116	0.0102	28512	7454	35966	10.1	362867
1100	97	78	0.0126	0.0102	22572	12778	35350	97.9	3459211
1100	92	78	0.0139	0.0102	16632	19699	36331	213.4	7752733
1100	87	78	0.0143	0.0102	10692	21828	32520	296.3	9637072
1100	82	78	0.0146	0.0102	4752	23426	28178	382.4	10775416
1100	67	70	0.0101	0.0062	3564	20764	24328	283.1	6887752
1100	62	70	0.0082	0.0062	9504	10648	20152	235.1	4737519
1100	57	70	0.0066	0.0062	15444	2130	17574	196.9	3459803
1100	52	70	0.0057	0.0062	21384	2662	24046	174.6	4199462
1100	47	70	0.0050	0.0062	27324	6389	33713	127.1	4283332
1100	42	70	0.0039	0.0062	33264	12245	45509	88.8	4038941
1100	37	70	0.0034	0.0062	39204	14907	54111	44.9	2430173
1100	32	70	0.0027	0.0062	45144	18634	63778	18.9	1207226
1100	27	70	0.0023	0.0062	51084	20764	71848	3.8	275843
1100	22	70	0.0017	0.0062	57024	23958	80982	2.0	159072
1100	17	70	0.0013	0.0062	62964	26088	89052	0.0	0
1100	12	70	0.0009	0.0062	68904	28217	97121	0.0	0

TOTAL COOLING KBTU FOR THE YEAR 31987
TOTAL HEATING KBTU FOR THE YEAR 31679
EQUIPMENT 8.57 BTU/WATT-HR COOLING KWH 3732

CARTER & BURGESS COST ESTIMATING ANALYSIS

PROJECT NAME: FORT SAM HOUSTON EEAP	PROJECT NO: 91109912F
PROJECT LOCATION: SAN ANTONIO, TEXAS	ESTIMATOR: C.M. JOHNSON
SUBMITTAL: 35.0%	DATE: 27-Oct-93
ECO NO/BUILDING:IV. F./BLDG 1387 HOOD 2	CHECKED BY: SPC

TASK DESCRIPTION	QUANTITY		LABOR				MATERIALS		TOTAL COST
	NO/UN	UNIT	MH UN	HRS	UN PRICE	COST	UN PRICE	COST	
						0.00		0.00	0
						0.00		0.00	0
3.5'X 10.5' HOOD	10.5	LF			44.50	467.25	400.00	4200.00	4667
COMB. SUPPLY EXHAUST UNIT	3.7	MCFM			119.00	440.30	660.00	2442.00	2882
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
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						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
SUBTOTAL						$908		$6,642	$7,550
OVERHEAD & PROFIT	10.00%								$755
TOTAL									$8,305

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 1387 – ECO IV. F.) – INSTALL MAKE-UP AIR SUPPLY FOR KITCHEN AREAS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 20 PREPARER C. M. JOHNSON

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$8,305		
B. SIOH	$457		
C. DESIGN COST	$498		
D. TOTAL COST (1A+1B+1C)	$9,260		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$9,260

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	29.82	$315	14.65	$4,609
B. DIST			$0	17.70	$0
C. RESID			$0	20.99	$0
D. NG	$3.31	74.16	$245	20.60	$5,057
E. PPG			$0	13.59	$0
F. COAL			$0	16.32	$0
G. SOLAR			$0	13.59	$0
H. GEOTH			$0	13.59	$0
I. BIOMA			$0	13.59	$0
J. REFUS			$0	13.59	$0
K. WIND			$0	13.59	$0
L. OTHER			$0	13.59	$0
M. DEMAND SAVINGS			$0	13.59	$0
N. TOTAL		103.98	$560		$9,666

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$0		
1. DISCOUNT FACTOR (TABLE A)			
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$0

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAVINGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) — $0

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): — 16.5 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): — $9,666

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: — 1.04

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): — 4.2%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's)

BUILDING NO. 2265

ECO NO: XI.A.

ECO NAME: Replace boilers with 99% efficient boilers.

SUMMARY DATA (DEPENDENT):

KWH Savings:	0	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	226.0	MCF/yr
Cost Savings:	$ 771	/yr
Implementation Cost:	$ 38,389	
Simple Payback:	49.8	Years

ECO DESCRIPTION:

This ECO analyzes replacing the existing domestic hot water boilers with 99% efficient boilers.

COST SAVINGS CALCULATIONS:

(Refer to following SimpCalc output)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

Form	Facility	ECRM Desc.	Page	KWH/Yr	KW	MCF/yr	mmBtu/Yr	$/Yr	Imp.Cost	PayBack
C9-01	BLDG 2265 MESS IN BARRACKS	Low Eff Hot Wat	26	0	.00	226.0	232.8	771	38389	49.8
		*** SUB-TOTAL ***		0	.00	226.0	232.8	771	38389	49.8
		*** SAVINGS % ***		.0 %		.0 %		.0 %		
	** GRAND TOTAL **			0	.00	226.0	232.8	771	38389	49.8

C9-001 Replace Low Efficiency DHW Units - BLDG 2265 MESS IN BARRACKS (G)

Cost Source: vender quote

Description: Install high efficiency water heater.

A)	4.80	Gal/person	Daily Hot Water Consumption per Capita (Table 10)
B)	486	People	Number of People in Facility
C)	365	Days	Days per Year of Occupancy
D)	140	Degree/F	Hot Water Temperature
E)	.7000		Heating Efficiency Existing
F)	.9900		Heating Efficiency Proposed
G)	30.50	mmBTU/yr	Standby Loss for Gas Water Heater
H)	.40		Reduction in Standby Loss
I) $	3.41	/MCF	Cost per MCF
J) $	38389	/Unit	Installed Cost of Replacement Unit
K)	496.5	mmBTU/yr	Annual BTU's for Hot Water
L)	730.9	MCF/year	Existing Unit Consumption
M)	504.9	MCF/year	Proposed Unit Consumption
N)	226.0	MCF/year	Total Consumption Savings
O) $	771	/year	Annual Cost Savings
P)	49.8	years	Simple Payback

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's)

BUILDING NO. 2399

ECO NO: IV. F. (Hood 1)

ECO NAME: Install make-up air supply for kitchen areas.

SUMMARY DATA (DEPENDENT):

KWH Savings:	8,916	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	132.2	MCF/yr
Cost Savings:	$ 772	/yr
Implementation Cost:	$ 12,411	
Simple Payback:	16.1	Years
Savings to Investment: Ratio (SIR):	1.13	

ECO DESCRIPTION:

Currently, the kitchen hoods in use do not contain supply air make-up. This ECO analyzes the addition of make-up air supply for the kitchen hoods.

COST SAVINGS CALCULATIONS:

(Refer to following spreadsheet)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

MODIFIED BIN METHOD CALCULATIONS

REFER TO ASHRAE 1993 FUNDAMENTALS

BLDG. NO.				44	368	407	1350	1387	1462	2399	2652
TIME OF OPERATION				6:00A 1:30P	6:00A 2:00P	7A-10P 7A-2P	4:00A 8:30P	10:00A 9:00P	9A-8:30P 9A-10:30P	5:00A 7:30P	10:00A 7:00P
DAYS/WEEK				5	5	4 , 3	6	5	5 , 2	7	4
DB RANGE	MID PT.	MC WB	HUMID RATIO	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.
100/104	102	74	0.0116	6.4	7.0	14.6	14.5	10.1	15.8	16.1	7.1
95/99	97	74	0.0126	59.4	64.8	139.8	139.4	97.9	152.8	153.4	67.7
90/94	92	74	0.0139	135.0	147.3	309.0	307.1	213.4	334.4	339.8	149.6
85/89	87	73	0.0143	173.8	189.6	418.5	418.7	296.3	461.3	458.6	202.9
80/84	82	72	0.0146	213.2	231.4	530.6	557.5	382.4	589.7	595.6	253.5
75/79	77	70	0.0142	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70/74	72	66	0.0123	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65/69	67	61	0.0101	196.1	208.4	418.7	527.9	283.1	433.6	535.7	183.2
60/64	62	56	0.0082	161.8	172.0	346.9	437.0	235.1	359.9	443.3	151.9
55/59	57	51	0.0066	132.3	140.5	288.0	363.6	196.9	300.7	367.8	126.2
50/54	52	47	0.0057	118.4	125.4	256.0	332.4	174.6	265.8	333.0	110.6
45/49	47	43	0.0050	92.0	96.8	190.1	260.7	127.1	192.8	257.6	79.5
40/44	42	38	0.0039	72.4	75.9	138.6	198.4	88.8	135.1	195.0	56.1
35/39	37	34	0.0034	44.4	46.1	75.5	120.8	44.9	68.1	116.1	28.1
30/34	32	29	0.0028	23.0	23.8	34.9	60.3	18.9	28.8	57.4	12.0
25/29	27	25	0.0023	8.3	8.4	9.6	21.3	3.8	5.8	19.4	2.4
20/24	22	20	0.0016	2.4	2.5	3.6	6.1	2.0	3.0	5.9	1.3
15/19	17	15	0.0013	0.4	0.4	0.3	0.9	0.0	0.0	0.8	0.0
10/14	12	10	0.0009	0.2	0.2	0.1	0.4	0.0	0.0	0.4	0.0

ASSUMPTIONS

1) SUMMER ROOM DESIGN: 78FDB, 50%RH
2) WINTER ROOM DESIGN: 70FDB, 40%RH
3) HUMIDITY RATIOS FOR THE SPACE BASED ON SUMMER & WINTER ROOM DESIGN TEMP.

EQUIPMENT:

SMALL AIR COOLED CHILLER (3-25 TONS): 8.57 BTU/WATT-H
LARGE AIR COOLED CHILLER (25-100 TONS): 8.63 BTU/WATT-H
SMALL WATER COOLED CHILLER (25-100 TONS): 11.11 BTU/WATT-H
LARGE WATER COOLED CHILLER (>100 TONS): 12.12 BTU/WATT-H

SYSTEM TYPES FOR ABOVE BUILDINGS

BUILDING NUMBER	SYSTEM TYPE
44	SMALL AIR COOLED
368	SMALL AIR COOLED
407	LARGE AIR COOLED
1350	LARGE WATER COOLED
1387	SMALL AIR COOLED
1462	LARGE AIR COOLED
2399	LARGE WATER COOLED
2652	LARGE AIR COOLED

ASSUME 40% CONDITIONED AIR IS EXHAUSTED
EXHAUST CFM=6FTx10FTx100FPM=6000CFM
BUILDING 2399

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
2400	102	78	0.0116	0.0102	62208	16262	78470	16.1	1260431
2400	97	78	0.0126	0.0102	49248	27878	77126	153.4	11829262
2400	92	78	0.0139	0.0102	36288	42979	79267	339.8	26931031
2400	87	78	0.0143	0.0102	23328	47626	70954	458.6	32536660
2400	82	78	0.0146	0.0102	10368	51110	61478	595.6	36614230
2400	67	70	0.0101	0.0062	7776	45302	53078	535.7	28433435
2400	62	70	0.0082	0.0062	20736	23232	43968	443.3	19491564
2400	57	70	0.0066	0.0062	33696	4646	38342	367.8	14102814
2400	52	70	0.0057	0.0062	46656	5808	52464	333.0	19296915
2400	47	70	0.0050	0.0062	59616	13939	73555	257.6	24493882
2400	42	70	0.0039	0.0062	72576	26717	99293	195.0	25574102
2400	37	70	0.0034	0.0062	85536	32525	118061	116.1	23021856
2400	32	70	0.0027	0.0062	98496	40656	139152	57.4	16150329
2400	27	70	0.0023	0.0062	111456	45302	156758	19.4	8994013
2400	22	70	0.0017	0.0062	124416	52272	176688	5.9	10137474
2400	17	70	0.0013	0.0062	137376	56918	194294	0.8	3776597
2400	12	70	0.0009	0.0062	150336	61565	211901	0.4	1244917

TOTAL COOLING KBTU FOR THE YEAR 109172
TOTAL HEATING KBTU FOR THE YEAR 194718
EQUIPMENT 12.12 BTU/WATT–HR COOLING KWH 12739

NOW 30% OF THE 2400 CFM IS EXHAUSTED
EXHAUST CFM=6FTx10FTx100FPM=6000CFM
BUILDING 2399

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
720	102	78	0.0116	0.0102	18662	4879	23541	16.1	378129
720	97	78	0.0126	0.0102	14774	8364	23138	153.4	3548778
720	92	78	0.0139	0.0102	10886	12894	23780	339.8	8079309
720	87	78	0.0143	0.0102	6998	14288	21286	458.6	9760998
720	82	78	0.0146	0.0102	3110	15333	18444	595.6	10984269
720	67	70	0.0101	0.0062	2333	13591	15924	535.7	8530031
720	62	70	0.0082	0.0062	6221	6970	13190	443.3	5847469
720	57	70	0.0066	0.0062	10109	1394	11503	367.8	4230844
720	52	70	0.0057	0.0062	13997	1742	15739	333.0	5789075
720	47	70	0.0050	0.0062	17885	4182	22067	257.6	7348164
720	42	70	0.0039	0.0062	21773	8015	29788	195.0	7672231
720	37	70	0.0034	0.0062	25661	9757	35418	116.1	6906557
720	32	70	0.0027	0.0062	29549	12197	41746	57.4	4845099
720	27	70	0.0023	0.0062	33437	13591	47028	19.4	2698204
720	22	70	0.0017	0.0062	37325	15682	53006	5.9	3041242
720	17	70	0.0013	0.0062	41213	17076	58288	0.8	1132979
720	12	70	0.0009	0.0062	45101	18469	63570	0.4	373475

TOTAL COOLING KBTU FOR THE YEAR 32751
TOTAL HEATING KBTU FOR THE YEAR 58415
EQUIPMENT 12.12 BTU/WATT–HR COOLING KWH 3822

CARTER & BURGESS COST ESTIMATING ANALYSIS

PROJECT NAME: FORT SAM HOUSTON EEAP	PROJECT NO: 91109912F
PROJECT LOCATION: SAN ANTONIO, TEXAS	ESTIMATOR: C.M. JOHNSON
SUBMITTAL: 35.0%	DATE: 27-Oct-93
ECO NO/BUILDING:IV. F./BLDG 2399 HOOD 1	CHECKED BY: SPC

TASK DESCRIPTION	QUANTITY		LABOR				MATERIALS		TOTAL
	NO/UN	UNIT	MH UN	HRS	UN PRICE	COST	UN PRICE	COST	COST
						0.00		0.00	0
						0.00		0.00	0
6'X 10' HOOD	10	LF			44.50	445.00	500.00	5000.00	5445
COMB. SUPPLY EXHAUST UNIT	6	MCFM			119.00	714.00	660.00	3960.00	4674
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
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						0.00		0.00	0
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						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
SUBTOTAL						$1,159		$8,960	$10,119
OVERHEAD & PROFIT	10.00%								$1,012
TOTAL									$11,131

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2399 – ECO IV. F.) – INSTALL MAKE-UP AIR SUPPLY FOR KITCHEN AREAS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 20 PREPARER C. M. JOHNSON

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$11,131		
B. SIOH	$612		
C. DESIGN COST	$668		
D. TOTAL COST (1A+1B+1C)	$12,411		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$12,411

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	30.43	$321	14.65	$4,703
B. DIST			$0	17.70	$0
C. RESID			$0	20.99	$0
D. NG	$3.31	136.30	$451	20.60	$9,294
E. PPG			$0	13.59	$0
F. COAL			$0	16.32	$0
G. SOLAR			$0	13.59	$0
H. GEOTH			$0	13.59	$0
I. BIOMA			$0	13.59	$0
J. REFUS			$0	13.59	$0
K. WIND			$0	13.59	$0
L. OTHER			$0	13.59	$0
M. DEMAND SAVINGS			$0	13.59	$0
N. TOTAL		166.73	$772		$13,997

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$0		
1. DISCOUNT FACTOR (TABLE A)			
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$0

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(–)

	ITEM	SAVINGS(+) COST(–)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV–INGS(+)COST(–)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $0

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 16.1 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $13,997

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 1.13

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 4.6%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's)

BUILDING NO. 2399

ECO NO: IV. F. (Hood 2)

ECO NAME: Install make-up air supply for kitchen areas.

SUMMARY DATA (DEPENDENT):

KWH Savings:	14,861	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	220.3	MCF/yr
Cost Savings:	$ 1,287	/yr
Implementation Cost:	$ 18,557	
Simple Payback:	14.4	Years
Savings to Investment: Ratio (SIR):	1.26	

ECO DESCRIPTION:

Currently, the kitchen hoods in use do not contain supply air make-up. This ECO analyzes the addition of make-up air supply for the kitchen hoods.

COST SAVINGS CALCULATIONS:

(Refer to following spreadsheet)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

MODIFIED BIN METHOD CALCULATIONS

REFER TO ASHRAE 1993 FUNDAMENTALS

BLDG. NO.				44	368	407	1350	1387	1462	2399	2652
TIME OF OPERATION				6:00A 1:30P	6:00A 2:00P	7A–10P 7A–2P	4:00A 8:30P	10:00A 9:00P	9A–8:30P 9A–10:30P	5:00A 7:30P	10:00A 7:00P
DAYS/WEEK				5	5	4 , 3	6	5	5 , 2	7	4
DB RANGE	MID PT.	MC WB	HUMID RATIO	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.
100/104	102	74	0.0116	6.4	7.0	14.6	14.5	10.1	15.8	16.1	7.1
95/99	97	74	0.0126	59.4	64.8	139.8	139.4	97.9	152.8	153.4	67.7
90/94	92	74	0.0139	135.0	147.3	309.0	307.1	213.4	334.4	339.8	149.6
85/89	87	73	0.0143	173.8	189.6	418.5	418.7	296.3	461.3	458.6	202.9
80/84	82	72	0.0146	213.2	231.4	530.6	557.5	382.4	589.7	595.6	253.5
75/79	77	70	0.0142	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70/74	72	66	0.0123	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65/69	67	61	0.0101	196.1	208.4	418.7	527.9	283.1	433.6	535.7	183.2
60/64	62	56	0.0082	161.8	172.0	346.9	437.0	235.1	359.9	443.3	151.9
55/59	57	51	0.0066	132.3	140.5	288.0	363.6	196.9	300.7	367.8	126.2
50/54	52	47	0.0057	118.4	125.4	256.0	332.4	174.6	265.8	333.0	110.6
45/49	47	43	0.0050	92.0	96.8	190.1	260.7	127.1	192.8	257.6	79.5
40/44	42	38	0.0039	72.4	75.9	138.6	198.4	88.8	135.1	195.0	56.1
35/39	37	34	0.0034	44.4	46.1	75.5	120.8	44.9	68.1	116.1	28.1
30/34	32	29	0.0028	23.0	23.8	34.9	60.3	18.9	28.8	57.4	12.0
25/29	27	25	0.0023	8.3	8.4	9.6	21.3	3.8	5.8	19.4	2.4
20/24	22	20	0.0016	2.4	2.5	3.6	6.1	2.0	3.0	5.9	1.3
15/19	17	15	0.0013	0.4	0.4	0.3	0.9	0.0	0.0	0.8	0.0
10/14	12	10	0.0009	0.2	0.2	0.1	0.4	0.0	0.0	0.4	0.0

ASSUMPTIONS

1) SUMMER ROOM DESIGN: 78FDB, 50%RH
2) WINTER ROOM DESIGN: 70FDB, 40%RH
3) HUMIDITY RATIOS FOR THE SPACE BASED ON SUMMER & WINTER ROOM DESIGN TEMP.

EQUIPMENT:

SMALL AIR COOLED CHILLER (3–25 TONS): 8.57 BTU/WATT–H
LARGE AIR COOLED CHILLER (25–100 TONS): 8.63 BTU/WATT–H
SMALL WATER COOLED CHILLER (25–100 TONS): 11.11 BTU/WATT–H
LARGE WATER COOLED CHILLER (>100 TONS): 12.12 BTU/WATT–H

SYSTEM TYPES FOR ABOVE BUILDINGS

BUILDING NUMBER	SYSTEM TYPE
44	SMALL AIR COOLED
368	SMALL AIR COOLED
407	LARGE AIR COOLED
1350	LARGE WATER COOLED
1387	SMALL AIR COOLED
1462	LARGE AIR COOLED
2399	LARGE WATER COOLED
2652	LARGE AIR COOLED

ASSUME 40% CONDITIONED AIR IS EXHAUSTED
EXHAUST CFM=5FTx20FTx100FPM=10,000CFM
BUILDING 2399

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
4000	102	78	0.0116	0.0102	103680	27104	130784	16.1	2100718
4000	97	78	0.0126	0.0102	82080	46464	128544	153.4	19715436
4000	92	78	0.0139	0.0102	60480	71632	132112	339.8	44885052
4000	87	78	0.0143	0.0102	38880	79376	118256	458.6	54227767
4000	82	78	0.0146	0.0102	17280	85184	102464	595.6	61023716
4000	67	70	0.0101	0.0062	12960	75504	88464	535.7	47389059
4000	62	70	0.0082	0.0062	34560	38720	73280	443.3	32485940
4000	57	70	0.0066	0.0062	56160	7744	63904	367.8	23504690
4000	52	70	0.0057	0.0062	77760	9680	87440	333.0	32161525
4000	47	70	0.0050	0.0062	99360	23232	122592	257.6	40823136
4000	42	70	0.0039	0.0062	120960	44528	165488	195.0	42623503
4000	37	70	0.0034	0.0062	142560	54208	196768	116.1	38369760
4000	32	70	0.0027	0.0062	164160	67760	231920	57.4	26917215
4000	27	70	0.0023	0.0062	185760	75504	261264	19.4	14990022
4000	22	70	0.0017	0.0062	207360	87120	294480	5.9	16895790
4000	17	70	0.0013	0.0062	228960	94864	323824	0.8	6294329
4000	12	70	0.0009	0.0062	250560	102608	353168	0.4	2074862
					TOTAL COOLING KBTU FOR THE YEAR				181953
					TOTAL HEATING KBTU FOR THE YEAR				324530
			EQUIPMENT 12.12 BTU/WATT–HR		COOLING KWH				21231

NOW 30% OF THE 400 CFM IS EXHAUSTED
EXHAUST CFM=5FTx20FTx100FPM=10,000CFM
BUILDING 2399

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
1200	102	78	0.0116	0.0102	31104	8131	39235	16.1	630215
1200	97	78	0.0126	0.0102	24624	13939	38563	153.4	5914631
1200	92	78	0.0139	0.0102	18144	21490	39634	339.8	13465516
1200	87	78	0.0143	0.0102	11664	23813	35477	458.6	16268330
1200	82	78	0.0146	0.0102	5184	25555	30739	595.6	18307115
1200	67	70	0.0101	0.0062	3888	22651	26539	535.7	14216718
1200	62	70	0.0082	0.0062	10368	11616	21984	443.3	9745782
1200	57	70	0.0066	0.0062	16848	2323	19171	367.8	7051407
1200	52	70	0.0057	0.0062	23328	2904	26232	333.0	9648457
1200	47	70	0.0050	0.0062	29808	6970	36778	257.6	12246941
1200	42	70	0.0039	0.0062	36288	13358	49646	195.0	12787051
1200	37	70	0.0034	0.0062	42768	16262	59030	116.1	11510928
1200	32	70	0.0027	0.0062	49248	20328	69576	57.4	8075165
1200	27	70	0.0023	0.0062	55728	22651	78379	19.4	4497007
1200	22	70	0.0017	0.0062	62208	26136	88344	5.9	5068737
1200	17	70	0.0013	0.0062	68688	28459	97147	0.8	1888299
1200	12	70	0.0009	0.0062	75168	30782	105950	0.4	622459
					TOTAL COOLING KBTU FOR THE YEAR				54586
					TOTAL HEATING KBTU FOR THE YEAR				97359
			EQUIPMENT 12.12 BTU/WATT–HR		COOLING KWH				6369
									100

CARTER & BURGESS COST ESTIMATING ANALYSIS

PROJECT NAME: FORT SAM HOUSTON EEAP	PROJECT NO: 91109912F
PROJECT LOCATION: SAN ANTONIO, TEXAS	ESTIMATOR: C.M. JOHNSON
SUBMITTAL: 35.0%	DATE: 27-Oct-93
ECO NO/BUILDING:IV. F./BLDG 2399 HOOD 2	CHECKED BY: SPC

TASK DESCRIPTION	QUANTITY		LABOR				MATERIALS		TOTAL
	NO/UN	UNIT	MH UN	HRS	UN PRICE	COST	UN PRICE	COST	COST
						0.00		0.00	0
						0.00		0.00	0
5'X 20' HOOD	20	LF			44.50	890.00	450.00	9000.00	9890
COMB. SUPPLY EXHAUST UNIT	10	MCFM			84.00	840.00	440.00	4400.00	5240
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
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						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
SUBTOTAL						$1,730		$13,400	$15,130
OVERHEAD & PROFIT	10.00%								$1,513
TOTAL									$16,643

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2399 – ECO IV. F.) – INSTALL MAKE–UP AIR SUPPLY FOR KITCHEN AREAS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 20 PREPARER C. M. JOHNSON

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$16,643		
B. SIOH	$915		
C. DESIGN COST	$999		
D. TOTAL COST (1A+1B+1C)	$18,557		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$18,557

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	50.72	$535	14.65	$7,839
B. DIST			$0	17.70	$0
C. RESID			$0	20.99	$0
D. NG	$3.31	227.17	$752	20.60	$15,490
E. PPG			$0	13.59	$0
F. COAL			$0	16.32	$0
G. SOLAR			$0	13.59	$0
H. GEOTH			$0	13.59	$0
I. BIOMA			$0	13.59	$0
J. REFUS			$0	13.59	$0
K. WIND			$0	13.59	$0
L. OTHER			$0	13.59	$0
M. DEMAND SAVINGS			$0	13.59	$0
N. TOTAL		277.89	$1,287		$23,329

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$0		
1. DISCOUNT FACTOR (TABLE A)			
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$0

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(–)

	ITEM	SAVINGS(+) COST(–)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV– INGS(+)COST(–)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $0

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 14.4 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $23,329

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 1.26

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 5.2%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's)

BUILDING NO. 2399

ECO NO: IV. F. (Hood 3)

ECO NAME: Install make-up air supply for kitchen areas.

SUMMARY DATA (DEPENDENT):

KWH Savings:	2,681	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	39.7	MCF/yr
Cost Savings:	$ 232	/yr
Implementation Cost:	$ 5,291	
Simple Payback:	22.8	Years
Savings to Investment: Ratio (SIR):	.80	

ECO DESCRIPTION:

Currently, the kitchen hoods in use do not contain supply air make-up. This ECO analyzes the addition of make-up air supply for the kitchen hoods.

COST SAVINGS CALCULATIONS:

(Refer to following spreadsheet)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

MODIFIED BIN METHOD CALCULATIONS

REFER TO ASHRAE 1993 FUNDAMENTALS

BLDG. NO.				44	368	407	1350	1387	1462	2399	2652
TIME OF OPERATION				6:00A 1:30P	6:00A 2:00P	7A–10P 7A–2P	4:00A 8:30P	10:00A 9:00P	9A–8:30P 9A–10:30P	5:00A 7:30P	10:00A 7:00P
DAYS/WEEK				5	5	4 , 3	6	5	5 , 2	7	4
DB RANGE	MID PT.	MC WB	HUMID RATIO	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.
100/104	102	74	0.0116	6.4	7.0	14.6	14.5	10.1	15.8	16.1	7.1
95/99	97	74	0.0126	59.4	64.8	139.8	139.4	97.9	152.8	153.4	67.7
90/94	92	74	0.0139	135.0	147.3	309.0	307.1	213.4	334.4	339.8	149.6
85/89	87	73	0.0143	173.8	189.6	418.5	418.7	296.3	461.3	458.6	202.9
80/84	82	72	0.0146	213.2	231.4	530.6	557.5	382.4	589.7	595.6	253.5
75/79	77	70	0.0142	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70/74	72	66	0.0123	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65/69	67	61	0.0101	196.1	208.4	418.7	527.9	283.1	433.6	535.7	183.2
60/64	62	56	0.0082	161.8	172.0	346.9	437.0	235.1	359.9	443.3	151.9
55/59	57	51	0.0066	132.3	140.5	288.0	363.6	196.9	300.7	367.8	126.2
50/54	52	47	0.0057	118.4	125.4	256.0	332.4	174.6	265.8	333.0	110.6
45/49	47	43	0.0050	92.0	96.8	190.1	260.7	127.1	192.8	257.6	79.5
40/44	42	38	0.0039	72.4	75.9	138.6	198.4	88.8	135.1	195.0	56.1
35/39	37	34	0.0034	44.4	46.1	75.5	120.8	44.9	68.1	116.1	28.1
30/34	32	29	0.0028	23.0	23.8	34.9	60.3	18.9	28.8	57.4	12.0
25/29	27	25	0.0023	8.3	8.4	9.6	21.3	3.8	5.8	19.4	2.4
20/24	22	20	0.0016	2.4	2.5	3.6	6.1	2.0	3.0	5.9	1.3
15/19	17	15	0.0013	0.4	0.4	0.3	0.9	0.0	0.0	0.8	0.0
10/14	12	10	0.0009	0.2	0.2	0.1	0.4	0.0	0.0	0.4	0.0

ASSUMPTIONS

1) SUMMER ROOM DESIGN: 78FDB, 50%RH
2) WINTER ROOM DESIGN: 70FDB, 40%RH
3) HUMIDITY RATIOS FOR THE SPACE BASED ON SUMMER & WINTER ROOM DESIGN TEMP.

EQUIPMENT:
SMALL AIR COOLED CHILLER (3–25 TONS): 8.57 BTU/WATT–H
LARGE AIR COOLED CHILLER (25–100 TONS): 8.63 BTU/WATT–H
SMALL WATER COOLED CHILLER (25–100 TONS): 11.11 BTU/WATT–H
LARGE WATER COOLED CHILLER (>100 TONS): 12.12 BTU/WATT–H

SYSTEM TYPES FOR ABOVE BUILDINGS

BUILDING NUMBER	SYSTEM TYPE
44	SMALL AIR COOLED
368	SMALL AIR COOLED
407	LARGE AIR COOLED
1350	LARGE WATER COOLED
1387	SMALL AIR COOLED
1462	LARGE AIR COOLED
2399	LARGE WATER COOLED
2652	LARGE AIR COOLED

ASSUME 40% CONDITIONED AIR IS EXHAUSTED
EXHAUST CFM=3FTx6FTx100FPM=1800CFM
BUILDING 2399

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
720	102	78	0.0116	0.0102	18662	4879	23541	16.1	378129
720	97	78	0.0126	0.0102	14774	8364	23138	153.4	3548778
720	92	78	0.0139	0.0102	10886	12894	23780	339.8	8079309
720	87	78	0.0143	0.0102	6998	14288	21286	458.6	9760998
720	82	78	0.0146	0.0102	3110	15333	18444	595.6	10984269
720	67	70	0.0101	0.0062	2333	13591	15924	535.7	8530031
720	62	70	0.0082	0.0062	6221	6970	13190	443.3	5847469
720	57	70	0.0066	0.0062	10109	1394	11503	367.8	4230844
720	52	70	0.0057	0.0062	13997	1742	15739	333.0	5789075
720	47	70	0.0050	0.0062	17885	4182	22067	257.6	7348164
720	42	70	0.0039	0.0062	21773	8015	29788	195.0	7672231
720	37	70	0.0034	0.0062	25661	9757	35418	116.1	6906557
720	32	70	0.0027	0.0062	29549	12197	41746	57.4	4845099
720	27	70	0.0023	0.0062	33437	13591	47028	19.4	2698204
720	22	70	0.0017	0.0062	37325	15682	53006	5.9	3041242
720	17	70	0.0013	0.0062	41213	17076	58288	0.8	1132979
720	12	70	0.0009	0.0062	45101	18469	63570	0.4	373475
					TOTAL COOLING KBTU FOR THE YEAR				32751
					TOTAL HEATING KBTU FOR THE YEAR				58415
					EQUIPMENT 12.12 BTU/WATT–HR COOLING KWH				3822

NOW 30% OF THE 720 CFM IS EXHAUSTED
EXHAUST CFM=3FTx6FTx100FPM=1800CFM
BUILDING 2399

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
215	102	78	0.0116	0.0102	5573	1457	7030	16.1	112914
215	97	78	0.0126	0.0102	4412	2497	6909	153.4	1059705
215	92	78	0.0139	0.0102	3251	3850	7101	339.8	2412572
215	87	78	0.0143	0.0102	2090	4266	6356	458.6	2914742
215	82	78	0.0146	0.0102	929	4579	5507	595.6	3280025
215	67	70	0.0101	0.0062	697	4058	4755	535.7	2547162
215	62	70	0.0082	0.0062	1858	2081	3939	443.3	1746119
215	57	70	0.0066	0.0062	3019	416	3435	367.8	1263377
215	52	70	0.0057	0.0062	4180	520	4700	333.0	1728682
215	47	70	0.0050	0.0062	5341	1249	6589	257.6	2194244
215	42	70	0.0039	0.0062	6502	2393	8895	195.0	2291013
215	37	70	0.0034	0.0062	7663	2914	10576	116.1	2062375
215	32	70	0.0027	0.0062	8824	3642	12466	57.4	1446800
215	27	70	0.0023	0.0062	9985	4058	14043	19.4	805714
215	22	70	0.0017	0.0062	11146	4683	15828	5.9	908149
215	17	70	0.0013	0.0062	12307	5099	17406	0.8	338320
215	12	70	0.0009	0.0062	13468	5515	18983	0.4	111524
					TOTAL COOLING KBTU FOR THE YEAR				9780
					TOTAL HEATING KBTU FOR THE YEAR				17443
					EQUIPMENT 12.12 BTU/WATT–HR COOLING KWH				1141

CARTER & BURGESS COST ESTIMATING ANALYSIS

PROJECT NAME: FORT SAM HOUSTON EEAP	PROJECT NO: 91109912F
PROJECT LOCATION: SAN ANTONIO, TEXAS	ESTIMATOR: C.M. JOHNSON
SUBMITTAL: 35.0%	DATE: 27-Oct-93
ECO NO/BUILDING:IV. F./BLDG 2399 HOOD 3	CHECKED BY: SPC

TASK DESCRIPTION	QUANTITY		LABOR				MATERIALS		TOTAL COST
	NO/UN	UNIT	MH UN	HRS	UN PRICE	COST	UN PRICE	COST	
						0.00		0.00	0
						0.00		0.00	0
3'X 6' HOOD	6	LF			44.50	267.00	400.00	2400.00	2667
COMB. SUPPLY EXHAUST UNIT	1.8	MCFM			140.00	252.00	775.00	1395.00	1647
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
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						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
SUBTOTAL						$519		$3,795	$4,314
OVERHEAD & PROFIT	10.00%								$431
TOTAL									$4,745

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2399 – ECO IV. F.) – INSTALL MAKE–UP AIR SUPPLY FOR KITCHEN AREAS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 20 PREPARER C. M. JOHNSON

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$4,745		
B. SIOH	$261		
C. DESIGN COST	$285		
D. TOTAL COST (1A+1B+1C)	$5,291		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$5,291

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	9.15	$97	14.65	$1,414
B. DIST			$0	17.70	$0
C. RESID			$0	20.99	$0
D. NG	$3.31	40.97	$136	20.60	$2,794
E. PPG			$0	13.59	$0
F. COAL			$0	16.32	$0
G. SOLAR			$0	13.59	$0
H. GEOTH			$0	13.59	$0
I. BIOMA			$0	13.59	$0
J. REFUS			$0	13.59	$0
K. WIND			$0	13.59	$0
L. OTHER			$0	13.59	$0
M. DEMAND SAVINGS			$0	13.59	$0
N. TOTAL		50.12	$232		$4,208

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$0		
1. DISCOUNT FACTOR (TABLE A)			
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$0

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(–)

	ITEM	SAVINGS(+) COST(–)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV–INGS(+)COST(–)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $0

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 22.8 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $4,208

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 0.80

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 2.8%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's)

BUILDING NO. 2399

ECO NO: XI.A

ECO NAME: Replace boilers with 99% efficient boilers.

SUMMARY DATA (DEPENDENT):

KWH Savings:	0	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	322.7	MCF/yr
Cost Savings:	$ 1,100	/yr
Implementation Cost:	$ 38,389	
Simple Payback:	34.9	Years

ECO DESCRIPTION:

This ECO analyzes replacing the existing domestic hot water boilers with 99% efficient boilers.

COST SAVINGS CALCULATIONS:

(Refer to following SimpCalc output)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

Form	Facility	ECRM Desc.	Page	KWH/Yr	KW	MCF/yr	mmBtu/Yr	$/Yr	Imp.Cost	PayBack
C9-01	BLDG 2399 HOSPITAL DINING	Low Eff Hot Wat	27	0	.00	322.7	332.4	1100	38389	34.9
		*** SUB-TOTAL ***		0	.00	322.7	332.4	1100	38389	34.9
	** GRAND TOTAL **			0	.00	322.7	332.4	1100	38389	34.9

C9-001 Replace Low Efficiency DHW Units - BLDG 2399 HOSPITAL DINING (G)

Cost Source: vender quote

Description: Install high efficiency water heater.

A)	9.60	Gal/person	Daily Hot Water Consumption per Capita (Table 10)
B)	275	People	Number of People in Facility
C)	365	Days	Days per Year of Occupancy
D)	140	Degree/F	Hot Water Temperature
E)	.6500		Heating Efficiency Existing
F)	.9900		Heating Efficiency Proposed
G)	38.10	mmBTU/yr	Standby Loss for Gas Water Heater
H)	.40		Reduction in Standby Loss
I)	$ 3.41	/MCF	Cost per MCF
J)	$ 38389	/Unit	Installed Cost of Replacement Unit
K)	561.9	mmBTU/yr	Annual BTU's for Hot Water
L)	896.2	MCF/year	Existing Unit Consumption
M)	573.5	MCF/year	Proposed Unit Consumption
N)	322.7	MCF/year	Total Consumption Savings
O)	$ 1100	/year	Annual Cost Savings
P)	34.9	years	Simple Payback

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's)

BUILDING NO. 2652

ECO NO: IV. F.

ECO NAME: Install make-up air supply for kitchen areas.

SUMMARY DATA (DEPENDENT):

KWH Savings:	9,704	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	96.0	MCF/yr
Cost Savings:	$ 677	/yr
Implementation Cost:	$ 13,011	
Simple Payback:	19.2	Years
Savings to Investment: Ratio (SIR):	.91	

ECO DESCRIPTION:

Currently, the kitchen hoods in use do not contain supply air make-up. This ECO analyzes the addition of make-up air supply for the kitchen hoods.

COST SAVINGS CALCULATIONS:

(Refer to following spreadsheet)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

MODIFIED BIN METHOD CALCULATIONS

REFER TO ASHRAE 1993 FUNDAMENTALS

BLDG. NO.				44	368	407	1350	1387	1462	2399	2652
TIME OF OPERATION				6:00A 1:30P	6:00A 2:00P	7A-10P 7A-2P	4:00A 8:30P	10:00A 9:00P	9A-8:30P 9A-10:30P	5:00A 7:30P	10:00A 7:00P
DAYS/WEEK				5	5	4 , 3	6	5	5 , 2	7	4
DB RANGE	MID PT.	MC WB	HUMID RATIO	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.
100/104	102	74	0.0116	6.4	7.0	14.6	14.5	10.1	15.8	16.1	7.1
95/99	97	74	0.0126	59.4	64.8	139.8	139.4	97.9	152.8	153.4	67.7
90/94	92	74	0.0139	135.0	147.3	309.0	307.1	213.4	334.4	339.8	149.6
85/89	87	73	0.0143	173.8	189.6	418.5	418.7	296.3	461.3	458.6	202.9
80/84	82	72	0.0146	213.2	231.4	530.6	557.5	382.4	589.7	595.6	253.5
75/79	77	70	0.0142	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70/74	72	66	0.0123	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65/69	67	61	0.0101	196.1	208.4	418.7	527.9	283.1	433.6	535.7	183.2
60/64	62	56	0.0082	161.8	172.0	346.9	437.0	235.1	359.9	443.3	151.9
55/59	57	51	0.0066	132.3	140.5	288.0	363.6	196.9	300.7	367.8	126.2
50/54	52	47	0.0057	118.4	125.4	256.0	332.4	174.6	265.8	333.0	110.6
45/49	47	43	0.0050	92.0	96.8	190.1	260.7	127.1	192.8	257.6	79.5
40/44	42	38	0.0039	72.4	75.9	138.6	198.4	88.8	135.1	195.0	56.1
35/39	37	34	0.0034	44.4	46.1	75.5	120.8	44.9	68.1	116.1	28.1
30/34	32	29	0.0028	23.0	23.8	34.9	60.3	18.9	28.8	57.4	12.0
25/29	27	25	0.0023	8.3	8.4	9.6	21.3	3.8	5.8	19.4	2.4
20/24	22	20	0.0016	2.4	2.5	3.6	6.1	2.0	3.0	5.9	1.3
15/19	17	15	0.0013	0.4	0.4	0.3	0.9	0.0	0.0	0.8	0.0
10/14	12	10	0.0009	0.2	0.2	0.1	0.4	0.0	0.0	0.4	0.0

ASSUMPTIONS

1) SUMMER ROOM DESIGN: 78FDB, 50%RH
2) WINTER ROOM DESIGN: 70FDB, 40%RH
3) HUMIDITY RATIOS FOR THE SPACE BASED ON SUMMER & WINTER ROOM DESIGN TEMP.

EQUIPMENT:

SMALL AIR COOLED CHILLER (3-25 TONS): 8.57 BTU/WATT-H
LARGE AIR COOLED CHILLER (25-100 TONS): 8.63 BTU/WATT-H
SMALL WATER COOLED CHILLER (25-100 TONS): 11.11 BTU/WATT-H
LARGE WATER COOLED CHILLER (>100 TONS): 12.12 BTU/WATT-H

SYSTEM TYPES FOR ABOVE BUILDINGS

BUILDING NUMBER	SYSTEM TYPE
44	SMALL AIR COOLED
368	SMALL AIR COOLED
407	LARGE AIR COOLED
1350	LARGE WATER COOLED
1387	SMALL AIR COOLED
1462	LARGE AIR COOLED
2399	LARGE WATER COOLED
2652	LARGE AIR COOLED

ASSUME 100% CONDITIONED AIR IS EXHAUSTED
EXHAUST CFM=5FTx12FTx100FPM=6000CFM
BUILDING 2652

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
6000	102	78	0.0116	0.0102	155520	40656	196176	7.1	1387245
6000	97	78	0.0126	0.0102	123120	69696	192816	67.7	13056398
6000	92	78	0.0139	0.0102	90720	107448	198168	149.6	29640271
6000	87	78	0.0143	0.0102	58320	119064	177384	202.9	35996282
6000	82	78	0.0146	0.0102	25920	127776	153696	253.5	38961936
6000	67	70	0.0101	0.0062	19440	113256	132696	183.2	24311803
6000	62	70	0.0082	0.0062	51840	58080	109920	151.9	16699969
6000	57	70	0.0066	0.0062	84240	11616	95856	126.2	12098397
6000	52	70	0.0057	0.0062	116640	14520	131160	110.6	16554266
6000	47	70	0.0050	0.0062	149040	34848	183888	79.5	20332759
6000	42	70	0.0039	0.0062	181440	66792	248232	56.1	19734444
6000	37	70	0.0034	0.0062	213840	81312	295152	28.1	16570677
6000	32	70	0.0027	0.0062	246240	101640	347880	12.0	9765489
6000	27	70	0.0023	0.0062	278640	113256	391896	2.4	4702752
6000	22	70	0.0017	0.0062	311040	130680	441720	1.3	567926
6000	17	70	0.0013	0.0062	343440	142296	485736	0.0	0
6000	12	70	0.0009	0.0062	375840	153912	529752	0.0	0

TOTAL COOLING KBTU FOR THE YEAR 119042
TOTAL HEATING KBTU FOR THE YEAR 141338
EQUIPMENT 8.63 BTU/WATT−HR COOLING KWH 13891

NOW 30% CONDITIONED AIR IS EXHAUSTED
EXHAUST CFM=5FTx12FTx100FPM=6000CFM
BUILDING 2652

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
1800	102	78	0.0116	0.0102	46656	12197	58853	7.1	416173
1800	97	78	0.0126	0.0102	36936	20909	57845	67.7	3916919
1800	92	78	0.0139	0.0102	27216	32234	59450	149.6	8892081
1800	87	78	0.0143	0.0102	17496	35719	53215	202.9	10798885
1800	82	78	0.0146	0.0102	7776	38333	46109	253.5	11688581
1800	67	70	0.0101	0.0062	5832	33977	39809	183.2	7293541
1800	62	70	0.0082	0.0062	15552	17424	32976	151.9	5009997
1800	57	70	0.0066	0.0062	25272	3485	28757	126.2	3629519
1800	52	70	0.0057	0.0062	34992	4356	39348	110.6	4966280
1800	47	70	0.0050	0.0062	44712	10454	55166	79.5	6099828
1800	42	70	0.0039	0.0062	54432	20038	74470	56.1	5920333
1800	37	70	0.0034	0.0062	64152	24394	88546	28.1	4971203
1800	32	70	0.0027	0.0062	73872	30492	104364	12.0	2929647
1800	27	70	0.0023	0.0062	83592	33977	117569	2.4	1410826
1800	22	70	0.0017	0.0062	93312	39204	132516	1.3	170378
1800	17	70	0.0013	0.0062	103032	42689	145721	0.0	0
1800	12	70	0.0009	0.0062	112752	46174	158926	0.0	0

TOTAL COOLING KBTU FOR THE YEAR 35713
TOTAL HEATING KBTU FOR THE YEAR 42402
EQUIPMENT 8.63 BTU/WATT−HR COOLING KWH 4167

CARTER & BURGESS COST ESTIMATING ANALYSIS

PROJECT NAME: FORT SAM HOUSTON EEAP	PROJECT NO: 91109912F
PROJECT LOCATION: SAN ANTONIO, TEXAS	ESTIMATOR: C.M. JOHNSON
SUBMITTAL: 35.0%	DATE: 27-Oct-93
ECO NO/BUILDING:IV. F./BLDG 2652 HOOD 1	CHECKED BY: SPC

TASK DESCRIPTION	QUANTITY		LABOR				MATERIALS		TOTAL COST
	NO/UN	UNIT	MH UN	HRS	UN PRICE	COST	UN PRICE	COST	
						0.00		0.00	0
						0.00		0.00	0
5'X 12' HOOD	12	LF			44.50	534.00	450.00	5400.00	5934
COMB. SUPPLY EXHAUST UNIT	6	MCFM			119.00	714.00	660.00	3960.00	4674
						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
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						0.00		0.00	0
						0.00		0.00	0
						0.00		0.00	0
SUBTOTAL						$1,248		$9,360	$10,608
OVERHEAD & PROFIT	10.00%								$1,061
TOTAL									$11,669

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2652 – ECO IV. F.) – INSTALL MAKE–UP AIR SUPPLY FOR KITCHEN AREAS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 20 PREPARER C. M. JOHNSON

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$11,669		
B. SIOH	$642		
C. DESIGN COST	$700		
D. TOTAL COST (1A+1B+1C)	$13,011		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$13,011

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	33.12	$349	14.65	$5,119
B. DIST			$0	17.70	$0
C. RESID			$0	20.99	$0
D. NG	$3.31	98.94	$327	20.60	$6,746
E. PPG			$0	13.59	$0
F. COAL			$0	16.32	$0
G. SOLAR			$0	13.59	$0
H. GEOTH			$0	13.59	$0
I. BIOMA			$0	13.59	$0
J. REFUS			$0	13.59	$0
K. WIND			$0	13.59	$0
L. OTHER			$0	13.59	$0
M. DEMAND SAVINGS			$0	13.59	$0
N. TOTAL		132.06	$677		$11,865

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$0		
1. DISCOUNT FACTOR (TABLE A)			
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$0

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV-INGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4)	$0
4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)):	19.2 YEARS
5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C):	$11,865
6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G:	0.91
7. ADJUSTED INTERNAL RATE OF RETURN (AIRR):	3.5%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's)

BUILDING NO. 2841

ECO NO: IX. A

ECO NAME: Replace boilers with 99% efficient boilers.

SUMMARY DATA (DEPENDENT):

KWH Savings:	5,092	KWH/yr
Demand Savings:	4.33	KW/yr
Gas Savings:	0	MCF/yr
Cost Savings:	$ 378	/yr
Implementation Cost:	$ 13,400	
Simple Payback:	35.4	Years

ECO DESCRIPTION:

This ECO analyzes replacing the existing domestic hot water boilers with 99% efficient boilers.

COST SAVINGS CALCULATIONS:

(Refer to following SimpCalc output)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

Form	Facility	ECRM Desc.	Page	KWH/Yr	KW	MCF/yr	mmBtu/Yr	$/Yr	Imp.Cost	PayBack
C2-01	BLDG 0368 CAFETERIA	Low Eff Cooling	11	5092	4.33	.0	17.4	378	13400	35.4
		*** SUB-TOTAL ***		5092	4.33	.0	17.4	378	13400	35.4
		*** SAVINGS % ***		.0 %		.0 %		.0 %		
	** GRAND TOTAL **			5092	4.33	.0	17.4	378	13400	35.4

C9-001 Replace Low Efficiency DHW Units - BLDG 2841 ACADEMY DINNING (G)

Cost Source: vender quote

Description: Install high efficiency water heater.

A)	2.40	Gal/person	Daily Hot Water Consumption per Capita (Table 10)
B)	250	People	Number of People in Facility
C)	365	Days	Days per Year of Occupancy
D)	140	Degree/F	Hot Water Temperature
E)	.6500		Heating Efficiency Existing
F)	.9900		Heating Efficiency Proposed
G)	38.10	mmBTU/yr	Standby Loss for Gas Water Heater
H)	.40		Reduction in Standby Loss
I)	$ 3.41	/MCF	Cost per MCF
J)	$ 38389	/Unit	Installed Cost of Replacement Unit
K)	127.7	mmBTU/yr	Annual BTU's for Hot Water
L)	247.6	MCF/year	Existing Unit Consumption
M)	147.7	MCF/year	Proposed Unit Consumption
N)	99.9	MCF/year	Total Consumption Savings
O)	$ 341	/year	Annual Cost Savings
P)	112.6	years	Simple Payback

C - MAINTENANCE AND OPERATIONAL RECOMMENDATIONS

I. ENVELOPE

A. Additional Insulation/Sealing

The ductwork for the rooftop unit serving the office area in Building 368 should be resealed.

IV. HVAC

E. Balance HVAC System

The make-up air kitchen hoods for Building 2265 have the make-up supply louvers closed. These supply louvers should be fully open in order for the hood to function properly.

V. BOILER/STEAM

A. Steam Trap Inspection

The steam traps for Building 2399 appear to be original to the building and should be replaced to prevent blow by of live steam.

X. REFRIGERATION EQUIPMENT

B. Add Plastic Air Curtains to Prevent Infiltration

The following buildings have walk-in freezers and refrigerators that do not have plastic air curtains or have torn curtains in need of replacement; Buildings 368, 407, 1387, 1395, 2399, 2841 and 5107. Addition or replacement of air curtains will reduce energy consumption due to infiltration and exfiltration.

XI. OTHER

B. Reduce Hot Water Temperature to 140°F

Currently, the domestic hot water temperature is set at 160°F for Building 368. This facility contains an automatic dishwasher with a booster heater for sanitization. The optimum temperature for the domestic hot water is 140°F. Reducing the temperature will result in a reduction in energy consumption.

C. Restore Operation of Ventilation Unit

Currently, a ventilation unit is disabled which is intended to serve the kitchen area for Building 5107. As a result, the kitchen hoods are exhausting conditioned air from the adjacent dining area. Restoring operation of this unit would reduce energy consumption related to the exhausted conditioned air.

D - CRITERIA AND REFERENCES

CRITERIA AND REFERENCES

1. OCE Architectural and Engineering
   Instruction Design Criteria
   November 20, 1990

2. Memorandum CEHSC-FU-M
   Energy Conservation Investment Program (ECIP)
   Guidance
   November 4, 1992

3. TM 5-802-1
   Economic Studies for Military Construction
   Design Applications
   December 1986

4. ASHRAE - Fundamentals Handbook 1993

5. ASHRAE - HVAC Applications Handbook 1991

6. Means Mechanical Cost Data 1993

7. Means Electrical Cost Data 1993

E - LIGHTING IMPLEMENTATION COSTS

LIGHTING IMPLEMENTATION COSTS

Below is a summary of the implementation costs (from Means and Defense General Supply)

LAMPS	MAT'L	LABOR
F32T8SP35	$1.98	3.0 min
F96T8SP35	$6.00	3.0 min
18 Watt PL w/reflector	$16.67	15.0 min
27 Watt PL w/ reflector	$21.00	15.0 min
Fluor. Exit Kit	$15.00	15.0 min
BALLASTS		
1-Lamp, Electronic	$18.00	30 min
2-Lamp, Electronic	$21.00	30 min
3-Lamp, Electronic	$26.00	30 min
4-Lamp, Electronic	$27.00	30 min
2-Lamp, 8'F96, Electronic	$32.00	30 min
FIXTURES		
2x4, 4-lamp w/T8 lamps, elect. ballasts	$88.00	45 min
8', 2-lamp industrial w/T8 lamps, electronic ballasts	$61.00	60 min

LABOR RATES	RATE W/ O&P	COST INDEX	RATE
Electrician	40.10	.699	$28.03
Technician	29.10	.699	$20.34

Note: The values listed above are utilized by the Flex program to calculate the implementation cost for lighting retrofits. The costs listed include all costs involved with a typical lighting retrofit for construction and demolition including; material, labor and disposal. Quantities of fixtures/lamps are indicated on the Flex output forms.

F - SCOPE OF WORK

DETAILED SCOPE OF WORK
CONTRACT NO. DCAC63-91-D-0048
DELIVERY ORDER NO. 000

1. The Architect-Engineer (A-E) shall furnish all services, material, supplies, plant, labor, equipment, investigations, studies, superintendence and travel as required in connection with the below identified project for design in accordance with the original basic contract and this Detailed Scope of Work. Appendix "A" of the basic contract shall be followed for performance requirements for A-E services. Where this Detailed Scope of Work shall govern.

INSTALLATION	PROJECT TITLE
FORT SAM HOUSTON	(EEAP), DINING FACILITIES STUDY

2. The work and other related data and services required in this Delivery Order shall be accomplished within the time schedule required, in accordance with the subject stated above and scope of work described in paragraph 3 below. The schedule for delivery of data to the Contracting Officer is in calendar days as follows:

	INDEFINITE DELIVERY CONTRACT	DELIVERY SCHEDULE
a. Interim Submittal(s) and Related data for Studies	*	120 calendar days after Notice to Proceed
b. Pre-Final Submittal(s)	*	120 calendar days after approval of Interim submittal
c. Final Submittal (original and All Data Developed under this Contract)	*	120 calendar days after approval of the Pre-Final Submittal

(See Annex "B" page B2 for Government Furnished Items)

3. The items of work included in this contract shall be in accordance with criteria furnished at the Scoping Conference held on April 22, 1993 at Fort Sam Houston. The services to be provided shall include, but not be limited to, the following Scope of Work.

a. Items of Work: (See the enclosed General and Detailed Scope of Work)

1. BRIEF DESCRIPTION OF WORK: The Architect-Engineer (AE) shall:

1.1 Perform a complete energy audit and analysis of the dining facilities.

1.2 Identify all Energy Conservation Opportunities (ECOs) including low cost/no cost ECOs and perform complete evaluations of each.

1.3 Provide complete programming or implementation documentation for all recommended ECOs.

1.4 List and prioritize all recommended energy conservation opportunities.

1.5 Prepare a comprehensive report which will document the work accomplished, the results and the recommendations.

2. GENERAL

2.1 An energy study, including a detailed energy survey, shall be accomplished for the dining facilities listed in Annex B. The study shall integrate the results of and any available data from prior or ongoing energy conservation studies, projects, designs, or plans with work done under this contract. This Scope of Work is not intended to prescribe the details in which the studies are to be conducted or limit the AE in the exercise of his professional engineering expertise, good judgment or investigative ingenuity. However, the information and analysis outlined herein are considered to be minimum essentials for adequate performance of this study. The study shall include a comprehensive energy report documenting study methods and results.

2.2 All recommended ECOs, including maintenance, operational and low cost/no cost opportunities as well as ECIP projects shall be ranked in order of highest to lowest Savings to Investment Ratio (SIR).

2.3 Other studies performed under the Energy Engineering Analysis Program(EEAP) have been accomplished for the installation at which the dining facilities are located. The portions of the studies applicable to the dining facilities, if any, shall be incorporated into this study. This report shall list the recommended dining facility related ECOs from the previous studies. This list shall identify the previous studies, summarize the dining facility related ECOs and the anticipated energy savings, and identify the fiscal year for which the project was or is programmed. The backup calculations and project documentation from the previous studies shall be reproduced and included as an appendix to the report. Any dining facility related ECOs identified in previous studies but not recommended shall be reevaluated under this contract. Any dining facility related ECOs recommended from the previous studies but not implemented nor programmed for implementation shall be updated in accordance with the latest ECIP guidance.

2.4 The AE shall ensure that all methods of energy conservation pertaining to dining facilities, which will reduce the energy consumption of the installation in compliance with the

Energy Resources Management Plan, have been considered and documented. All methods of energy conservation which are reasonable and practical shall be considered, including improvements of operational methods and procedures as well as the physical facilities. All new and updated energy conservation opportunities which produce energy or dollar savings shall be documented in this report. Any energy conservation opportunities considered infeasible shall be documented in the report with reasons for elimination. A list of general energy conservation opportunities is included as Annex A to this scope.

2.5 The study shall consider the use of all energy sources. The energy sources may include electricity, natural gas, liquefied petroleum gas, bulk oil, other oil products, steam when procured, gasoline, coal, solar, etc.

2.6 The "Energy Conservation Investment Program (ECIP) Guidance," described in a letter from CEHSC-FU, dated 4 Nov 1992 and revised by letter from CEHSC-FU-P establishes criteria for ECIP projects and shall be used for performing the economic analyses of all ECOs and projects. Construction cost escalation for DD Form 1391 submission shall be calculated using the guidelines contained in AR 415-17 and the latest Tri-Service MCP index. The Tri-Service MCP Index, when updated, is contained in the latest applicable edition of the Engineer Improvement Recommendation System (EIRS) bulletin.

2.7 Computer Modeling will be used to determine the energy savings of ECOs which would replace or significantly change an existing heating, ventilating, and air-conditioning (HVAC) system. The requirement to use computer modeling applies only to heated and air-conditioned or air-conditioned-only buildings which exceed 8000 square feet or heated-only buildings in excess of 20,000 square feet. Modeling will be done using a professionally recognized and proven computer program or programs that integrate architectural features with air-conditioning, heating, lighting and other energy-producing or consuming systems. These programs will be capable of simulating the features, systems, and thermal loads of the building under study. The program will use established weather data files and may perform calculations on a true hour-by-hour basis or may condense the weather files and the number of calculations into several "typical" days per month. The Detailed Scope of Work, Annex B, will list programs that are acceptable to the Contracting Officer. If the AE desires to use a different program, it must be submitted for approval with a sample run, an explanation of all input and output data, and a summary of program methodology and energy evaluation capabilities.

2.8 Energy conservation opportunities determined to be technically and economically feasible shall be developed into projects acceptable to installation personnel. This may involve combining similar ECOs into larger packages which will qualify for ECIP or MCA funding, and determining, in coordination with installation personnel, the appropriate packaging and implementation approach for all feasible ECOs.

2.8.1 Projects which qualify for ECIP funding shall be identified, separately listed, and prioritized by the Savings to Investment Ratio (SIR).

2.8.2 All feasible non-ECIP projects shall be ranked in order of highest to lowest SIR.

2.8.3 At some installations, Energy Conservation and Management (ECAM) funding will be used instead of ECIP funding. The criteria for each program is the same. The Director of Engineering and Housing will indicate which program is used at this installation. This Scope of Work mentions only ECIP, however, ECAM is also meant.

3. PROJECT MANAGEMENT

3.1 Project Managers. The AE shall designate a project manager to serve as a point of contact and liaison for work required under this contract. Upon award of this contract, the individual shall be immediately designated in writing. The AE's designated project manager shall be approved by the Contracting Officer prior to commencement of work. This designated individual shall be responsible for coordination of work required under this contract. The Contracting Officer will designate a project manager to serve as the Government's point of contact and liaison for all work required under this contract. This individual will be the Government's representative.

3.2 Installation Assistance. The Commanding Officer at each installation will designate an individual who will serve as the point of contact for obtaining information and assisting in establishing contacts with the proper individuals and organizations as necessary in the accomplishment of the work required under this contract.

3.3 Public Disclosures. The AE shall make no public announcements or disclosures relative to information contained or developed in this contract, except as authorized by the Contracting Officer.

3.4 Meetings. Meetings will be scheduled whenever requested by the AE or the Contracting Officer for the resolution of questions or problems encountered in the performance of the work. The AE and/or the designated representative(s) shall be required to attend and participate in all meetings pertinent to the work required under this contract as directed by the Contracting Officer. These meetings, if necessary, are in addition to the presentation and review conferences.

3.5 Site Visits, Inspections, and Investigations. The AE shall visit and inspect/investigate the site of the project as necessary and required during the preparation and accomplishment of the work.

3.6 Records

3.6.1 The AE shall provide a record of all significant conferences, meetings, discussions, verbal directions, telephone conversations, etc., with Government representative(s) relative to this contract in which the AE and/or designated representative(s) thereof participated. These records shall be dated and shall identify the contract number, and modification number if

applicable, participating personnel, subject discussed and conclusions reached. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the records.

3.6.2 The AE shall provide a record of requests for and/or receipt of Government-furnished material, data, documents, information, etc., which if not furnished in a timely manner, would significantly impair the normal progression of the work under this contract. The records shall be dated and shall identify the contract number and modification number, if applicable. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the record of request or receipt of material.

3.7 Interviews. The AE and the Government's representative shall conduct entry and exit interviews with the Director of Engineering and Housing before starting work at the installation and after completion of the field work. The Government's representative shall schedule the interviews at least one week in advance.

3.7.1 Entry. The entry interview shall describe the intended procedures for the survey and shall be conducted prior to commencing work at the facility. As a minimum, the interview shall cover the following points:

a. Schedules.

b. Names of energy analysts who will be conducting the site survey.

c. Proposed working hours.

d. Support requirements from the Director of Engineering and Housing.

3.7.2 Exit. The exit interview shall briefly describe the items surveyed and probable areas of energy conservation. The interview shall also solicit input and advice from the Director of Engineering and Housing.

4. SERVICES AND MATERIALS. All services, materials (except those specifically enumerated to be furnished by the Government), labor, superintendence and travel necessary to perform the work and render the data required under this contract are included in the lump sum price of the contract.

5. PROJECT DOCUMENTATION. All energy conservation opportunities shall be included in one of the following categories and presented in the report as such:

5.1 ECIP Projects. To qualify as an ECIP project, an ECO, or several ECOs which have been combined, must have a construction cost estimate greater than $300,000, a Savings to Investment Ratio greater than one and a simple payback period of less than ten years. The overall project, and each discrete part of the project, shall have a SIR greater than one. For all projects meeting the above criteria, complete programming documentation will be required.

.Programming documentation shall consist of a DD Form 1391, life cycle cost analysis summary sheet(s) (with necessary backup data to verify the numbers presented), and a project development brochure (PDB). A life cycle cost analysis summary sheet shall be developed for each ECO and for the overall project when more than one ECO are combined. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs. For projects and ECOs reevaluated from previous studies, the backup data shall consist of copies of the original calculations and analysis, with new pages updating and revising the original calculations and analysis. In addition, the backup data shall include as much of the following as is available: the increment of work the project or ECO was developed under in the previous study, title(s) of the project(s), the energy to cost (E/C) ratio, the benefit to cost (B/C) ratio, the current working estimate (CWE), and the payback period. This information shall be included as part of the backup data. The purpose of this information is to provide a means to prevent duplication of projects in any future reports.

5.2 Non-ECIP Projects. Projects which do not meet ECIP criteria with regard to cost estimate or payback period, but which have an SIR greater than one shall be documented. Projects or ECOs in this category shall be provided with the following documentation: the life cycle cost analysis (LCCA) summary sheet completely filled out, a description of the work to be accomplished, backup data for the LCCA, i.e., energy savings calculations and cost estimate(s), and the simple payback period. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs. In addition these projects shall have the necessary documentation prepared, as required by the Government's representative, for one of the following categories:

a. Quick Return on Investment Program (QRIP). This program is for projects which have a total cost greater than $3000 but less than $100,000 and a simple payback period of two years or less.

b. Productivity Enhancing Capital Investment Program (PECIP). This program is for projects which have a total cost of greater than $3000 but less than $100,000 and a simple payback period of four years or less.

c. OSD Productivity Investment Funding (OSD PIF). This program is for projects which have a total cost of more than $100,000 and a simple payback period of four years or less.

The above programs and the required documentation forms are all described in detail in AR 5-4, Change No. 1.

d. Regular Military Construction Army (MCA) Program. This program is for projects which have a total cost greater than $300,000 and a simple payback period of four to twenty-five years. Documentation shall consist of DD form 1391 and a Project Development Brochure.

e. Low Cost/No Cost Projects. These are projects which the Director of Engineering and Housing (DEH) can perform with his resources. Documentation shall be as required by the

DEH.

5.3 Nonfeasible ECOs. All ECOs which the AE has considered but which are not feasible, shall be documented in the report with reasons and justifications showing why they were rejected.

6. DETAILED SCOPE Of WORK. The general Scope of Work is intended to apply to contract efforts for all Army dining facilities included under this contract except as modified by the detailed Scope of Work for each individual installation. The detailed Scope of Work is contained in Annex B.

7. WORK TO BE ACCOMPLISHED

7.1 Audit and Analysis

7.1.1 Audit. The audit consists of gathering data and inspecting the dining facilities in the field. These activities shall be closely coordinated with the Government's representative and the Director of Engineering and Housing. The AE shall become familiar with each dining facility and undertake all necessary field trips to obtain required data. The AE shall document his field surveys on forms developed for the survey, or standard forms, and submit the completed forms as part of the report. Data sources shall be identified and assumptions clearly stated and justified. Data collected during the audit shall be in sufficient detail to identify all the major energy using equipment and processes. The AE shall measure and record the voltage and amperage of all motors one horsepower and larger. The information gathered shall be compared to the name plate data to determine whether the motor is being properly utilized. Data should be gathered when the motor is loaded. Air handling system supply, return and exhaust air quantities, temperatures, relative humidities, lighting levels, number and type of light fixtures, differential pressure readings, domestic hot water temperatures, and similar data required for the analysis shall be based on measurements made during the audit and not on "as-built" drawings. All test and/or measurement equipment shall be properly calibrated prior to its use. Operating sequences for equipment, control schedules, facility operating hours, methods of operation, and past performance records should also be obtained during the audit.

7.1.2 Analysis. The energy analysis is a comprehensive study of the dining facilities energy usage. It includes a detailed investigation of the facilities operation, its environment and its equipment. The energy analysis shall provide the following types of information: (a) a baseline of energy usage of the existing dining facility, (b) peak heating and cooling loads, (c) energy usage by systems (lighting, heating, cooling, domestic hot water, etc.), (d) a basis for evaluating ECOs, and (e) a baseline of energy usage of the dining facility after incorporation of all recommended ECOs. The AE shall develop graphic presentations, i.e., graphs and charts, which depict a complete energy consumption picture for the dining facilities as they are now and after implementation of the recommended energy conservation opportunities and include these in the report.

7.2 Identify ECOs. All methods of energy conservation which are reasonable and practical shall be considered, including improvements of operational methods and procedures and maintenance practices as well as the physical facilities. A list of energy conservation opportunities is included as Annex A to this scope. This list is not intended to be restrictive but only to assure that at least these opportunities are considered, discussed and documented in the report. Those items on the list which are not practical, have been previously accomplished, are inappropriate or can be eliminated from detailed analysis based on preliminary analysis shall be listed in the report along with the reason for elimination from further analysis. All potential ECOs which are not eliminated by preliminary considerations shall be thoroughly documented and evaluated as to technical and economic feasibility. The AE shall provide all data and calculations needed to support the recommended ECO. All assumptions shall be clearly stated. Calculations shall be prepared showing how all numbers in the ECO were figured. Calculations shall be an orderly step-by-step progression from the first assumption to the final number. Descriptions of the products, manufacturers catalog cuts, pertinent drawings and sketches shall also be included. A life cycle cost analysis summary sheet shall be prepared for each ECO and included as part of the supporting data.

7.3 Provide Programming or Implementation Documentation
During the Interim Review Conference, as outlined in pragraph 7.5.1, the AE will be advised of the DEH's preferred packaging of recommended ECOs into projects for implementation. These projects will be documented as outlined in paragraphs 5.1, 5.2, and 5.3. Programming documentation will be included in the Prefinal Submittal per par 7.5.2. Programming documents shall be bound similarly to the final report in a manner which will facilitate repeated disassembly and reassembly.

7.4 List and Prioritize All Projects.

7.4.1 The AE shall list and prioritize all energy conservation opportunities by savings to investment ratios.

7.4.2 The AE shall list and prioritize all projects by types of projects and savings to investment ratios.

7.5 Submittals, Presentations and Reviews. The work accomplished shall be fully documented by a comprehensive report. The report shall have a table of contents and be indexed. Tabs and dividers shall clearly and distinctly divide sections, subsections, and appendices. All pages shall be numbered. The AE shall give a formal presentation of all but the final submittal to installation, command, and other Government personnel. The AE shall prepare slides or view graphs showing the results of the study to date for his presentation. During the presentation, the personnel in attendance shall be given ample opportunity to ask questions and discuss any changes deemed necessary to the study. A review conference will be conducted the same day, following the presentation. Each comment presented at the review conference will be discussed and resolved or action items assigned. The AE shall provide the comments from all reviewers and written notification of the action taken on each comment to

all reviewing agencies within three weeks after the review meeting. It is anticipated that each presentation and review conference will require approximately one working day. The presentation and review conferences will be at the installation on the date(s) agreeable to the Director of Engineering and Housing, the AE and the Government's representative. The Contracting Officer may require a resubmittal of any document(s), if such document(s) are not approved because they are determined by the Contracting Officer to be inadequate for the intended purpose.

7.5.1 Interim Submittal. An interim report shall be submitted for review after the field survey has been completed and an analysis has been performed on all of the ECOs. The report shall indicate the work which has been accomplished to date, illustrate the methods and justifications of the approaches taken and contain a plan of the work remaining to complete the study. Calculations showing energy and dollar savings and SIRs of all the ECOs shall be included. The simple payback period of all ECOs shall be calculated and shown in the report. The AE shall submit the Scope of Work and any modifications to the Scope of Work as an appendix to the report. A narrative summary describing the work and results to date shall be a part of this submittal. During the review period, the Government's representative shall coordinate with the Director of Engineering and Housing and provide the AE with direction for packaging or combining ECOs for programming purposes and also indicate the fiscal year for which the programming or implementation documentation shall be prepared. A sample implementation document (DA Form 5108-R, sketches and manufacturers data, life cycle cost analysis summary sheet and supporting data) for one project shall be submitted with this submittal for review and approval. The survey forms completed during this audit shall be submitted with this report. The survey forms only may be submitted in final form with this submittal. They should be clearly marked at the time of submission that they are to be retained. They shall be bound in a standard three-ring binder which will allow repeated disassembly and reassembly of the material contained within.

7.5.2 Prefinal Submittal. The AE shall prepare and submit the prefinal report when all work under this contract is complete. The AE shall submit the Scope of Work for the installation studied and any modifications to the Scope of Work as an appendix to the submittal. The report shall contain a narrative summary of conclusions and recommendations, together with all raw and supporting data, methods used, and sources of information. The report shall integrate all aspects of the study. The report shall include an order of priority by SIR in which the recommended ECOs should be accomplished. The synergistic effects of all of the ECOs on one another shall have been determined and the results of the original calculations adjusted accordingly. Completed programming and implementation documents for all recommended projects shall be included. The programming and implementation documents shall be ready for review and signature by the installation commander. The prefinal report, separately bound Executive Summary and all appendices shall be bound in standard three-ring binders which will allow repeated disassembly and reassembly. The prefinal submittal shall be arranged to include (a) a separately bound Executive Summary to give a brief overview of what was accomplished and the results of this study using graphs, tables and charts as much as possible (See Annex D for minimum requirements), (b) the narrative report containing a copy of the Executive

Summary at the beginning of the volume and describing in detail what was accomplished and the results of this study, (c) appendices to include the detailed calculations and all backup material and (d) the programming and implementation documentation. A list of all projects and ECOs developed during this study shall be included in the Executive Summary and shall include the following data from the life cycle cost analysis summary sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple payback period and the analysis date. For all programmed projects also include the year in which it is programmed and the programmed year cost.

7.5.3 Final Submittal. Any revisions or corrections resulting from comments made during the review of the prefinal report or during the presentation and review conference shall be incorporated into the final report. These revisions or corrections may be in the form of replacement pages, which may be inserted in the prefinal report, or complete new volumes. Pen and ink changes or errata sheets will not be acceptable. If replacement pages are to be issued, it shall be clearly stated with the prefinal submittal that the submitted documents will be changed only to comply with the comments made during the prefinal conference and that the volumes issued at the time of the prefinal submittal should be retained. Failure to do so will require resubmission of complete volumes. If new volumes are submitted, they shall be in standard three-ring binders and shall contain all the information presented in the prefinal report with any necessary changes made. Detailed instructions of what to do with the replacement pages should be securely attached to the replacement pages.

FORT SAM HOUSTON – DINING FACILITIES			
	BUILDING	SQ.FT.	FUNCTION
	44	1,520	SNACK BAR
	48	500	VIP GUEST HOUSE
	368	5,720	CAFETERIA
	407	5,500	OFFICER CLUB
	1350	18,000	DINING FACILITY
	1387	2,000	MINI–MALL
	1395	6,000	NCE
	1462	5,000	SNACK BAR
	1630	820	YOUTH CENTER
	2265	24,340	MESS HALL IN BARRACKS
	2399	25,900	ACADEMY (BLDG UNDER STUDY)
	2521	500	SNACK BAR
	2530	3,000	NEW CHILD CARE CENTER
	2652	4,000	DINNER THEATRE
	2841	15,500	ACADEMY CLASSROOM
CAMP BULLIS			
	5106	3,500	
	5105	3,400	
	5107	3,400	
	5114	3,400	
	5124	3,600	
	1520	25,800	
TOTAL	21	161,400	

ANNEX A

GENERAL ENERGY CONSERVATION OPPORTUNITIES

ENVELOPE

- o Insulation (wall, roof, pipe, duct, etc.)
- o Insulated glass or double glazed windows
- o Weather stripping and caulking

[redacted]

HOT WATER

- o Shutdown energy to hot water heaters or modify controls
- o Booster heaters at major hot water users

[redacted]

- o Instantaneous hot water heater

HEAT RECOVERY

- o Heat recovery from dishwasher hot water
- o Heat reclaim from kitchen exhaust
- o Waste heat recovery

HVAC

- o Night setback/setup thermostats

[redacted]

- o Economizer cycles (dry bulb)
- o Upgrade HVAC controls
- o Make HVAC operations more efficient
- o Balance HVAC systems

[redacted]

- o Install make-up air supply for kitchen area
- o Shut off range hood exhaust whenever possible
- o Thermal storage

[redacted]

- o Replace kitchen exhaust hoods with energy efficient models

BOILER/STEAM

- o Steam trap inspection
- o Insulate steam and condensate lines

POWER

- o Convert to energy efficient/smaller motors

OPTIMAL OPERATION

[redacted]

REDUCE/ENHANCE LIGHTING

[redacted]

- o Photocells for lighting
- o Timers for lighting
- o ~~Separate switches to control lighting arrangements~~
- o Remove unneeded lamps or fixtures
- o Reduce indoor or outdoor lighting where illumination exceeds AEI recommended levels

[redacted]

- o Lower light fixtures
- o Improve reflection and dispersion with light-colored ceilings and walls

IMPROVE LIGHTING CONTROLS

- o Install occupancy sensors to control lighting where applicable
- o Install additional switches to control lighting arrangements

IMPROVE LIGHTING EFFICIENCY

- o Replace incadescent lamps with compact fluorescent lamps
- o Replace incandescent exit sign fixtures with LED fixtures

[redacted]

- o Replace standard fluorescent lamps with energy-conserving lamps
- o Replace standard fluorescent ballasts with electronic ballasts

[redacted]

- o Replace existing fluorescent fixtures with new fixtures having efficient reflectors, electronic ballasts, and energy-conserving lamps

IMPROVE EFFICIENCY OF REFRIGERATION & FREEZER EQUIPMENT.

ANNEX B

GUIDE TO THE PREPARATION OF THE DETAILED SCOPE OF WORK

1. This annex will contain the detailed Scope of Work for the energy audit of the dining facilities at this installation. The information presented below is to be used as a guide in preparing the detailed Scope of Work. This statement and the statements below should not appear in the final contract documents. The generalized Scope of Work and the detailed scope of work must combine to form a clear and concise statement of the requirements for the study. They must be reviewed carefully and edited as necessary to eliminate mutual conflicts and to provide needed details.

2. If the general Scope of Work covers more than one installation under a contract, a separate detailed Scope of Work will be prepared for each installation.

3. The project manager will schedule a meeting at the installation with the Director of Engineering and Housing (DEH) and the Energy Officer. This meeting should be scheduled after these individuals have received the general Scope of Work and indicated that they are receptive to an energy survey of their dining facilities. Troop Support Agency (LOTA-EM-E), the Division and the MACOM should be invited to this meeting. The above offices should be notified a minimum of three weeks in advance of this meeting. The purpose of this meeting will be to inform the installation what this survey is to accomplish, to discuss the general Scope of Work, answer any questions pertaining to it and to develop the detailed Scope of Work. The following information is necessary when developing the detailed Scope of Work and the DEH should be prepared to provide it at this meeting:

a. Dining facilities that should be included in this energy study. Temporary buildings should be separately identified. Provide building names and numbers, type of building, size, whether building is typical of any others, etc.

b. Any specific energy conservation opportunities (ECOs) pertaining to the dining facilities that should be looked at in this study. —

c. The status of any recommended projects from any previous studies.

d. Which ECOs in Annex A are not applicable at this installation.

Sufficient time should be allowed to obtain the above information.

4. Each detailed Scope of Work will include, but not be limited to, the following:

a. The schedule for completion of the study including milestone dates or time allowed, measured in calendar days from the notice to proceed, for each submittal.

b. The requirements as to the number of copies of each submittal required and the complete mailing addresses of those who are to receive the submittals.

c. An itemized list of Government furnished information to be provided to the AE. As a minimum, this list should include:

(1) Final reports of previously completed studies performed under the Energy Engineering Analysis Program (EEAP). Only portions pertaining to dining facilities, if any, need to be made available.

(2) Latest copies of other energy studies performed since the previous EEAP study. Only portions pertaining to dining facilities, if any, need to be made available.

(3) Energy Resources Management Plan.

(4) ETLs 1110-3-282, Energy Conservation and 1110-3-332, Economic Studies.

(5) Architectural and Engineering Instructions.

(6) Energy Conservation Investment Program (ECIP) Guidance, dated 4 November 1992.

(7) TM 5-785, Engineering Weather Data; TM 5-800-2, General Criteria - Preparation of Cost Estimates; and TM 5-800-3, Project Development Brochure.

(8) AR 415-15, Military Construction Army (MCA) Program Development; AR 415-17, Cost Estimating for Military Programming; AR 415-20, Construction, Project Development and Design Approval; AR 415-28, Department of the Army Facility Classes and Construction Categories; AR 415-35, Construction, Minor Construction; AR 420-10, General Provisions, Organization, Functions, and Personnel; AR 11-27, Army Energy Program, and AR 5-4, Change No. 1, Department of the Army Productivity Improvement Program.

(9) The latest applicable Engineering Improvement Recommendation System (EIRS) bulletin.

(10) An example of a correctly completed implementation document for a project.

(DA FORM 5108-R)

5. When developing the detailed Scope of Work, the Director of Engineering and Housing, the Energy Officer and the project manager shall go over the energy conservation opportunities (ECOs) listed in Annex A and indicate on that list the ECOs which are not applicable for this installation. This will let the AE know which ECOs are not applicable, so as to avoid duplication of work. Additionally, ECOs should be added to the list in Annex A if their feasibility appears likely.

6. The detailed Scope of Work will list those buildings or facilities which will be included in the study. If temporary building(s) are to be included in this energy study with the intent of developing an ECIP project incorporating them, a letter is required stating that there is a continuing need of the building for a ten year period after the retrofit or for the life of the retrofit. The continuing need must be based on the installation's annual real property utilization survey (AR 405- 70). This letter must be signed by the base commander and be ready no later than the prenegotiation meeting or the temporary building(s) will be removed from the list of buildings to be included in the study. This letter is not required if temporary buildings are to be included in low cost/no cost or non-ECIP projects only.

7. The Director of Engineering and Housing should designate a coordinator to serve as the point of contact and liaison for all work required under this contract. This individual should be identified in the detailed Scope of Work.

8. If it is known that the buildings in this study will not be subject to the computer modeling requirements of paragraph 2.7 of the general scope of work, then paragraph 2.7 should be deleted. If it is possible that the buildings in this study will be subject to the computer modeling requirements of paragraph 2.7, then the simulation programs acceptable to the office doing the technical review should be listed in the detailed scope of work. Some acceptable simulation programs follow:

a. Building Loads and System Thermodynamics (BLAST) *

b. DOE 2.1B *

c. Carrier E20 or Hourly Analysis Program (HAP) **

d. Trane Air-conditioning Economics (TRACE) **

* Very accurate, but requires a lot of time for input; therefore it is rather expensive for straightforward projects.
** Adequate for load determination, equipment selection, and energy performance for most projects.

This list may be expanded, contracted, or revised to include programs with which the reviewers are familiar provided such programs comply with Chapter 28, "Energy Estimating Methods" of

the ASHRAE Handbook of Fundamentals.

9. If the Director of Engineering and Housing has requirements for project documentation other than what is shown in paragraph 7.3 of the general Scope of Work, such as Work Order, DA Form 4283, these requirements should be clearly stated in this annex or the paragraphs modified as necessary.

10. If the installation has an Energy Monitoring and Control System (EMCS) that is outdated or if additional points need to be added to include the dining facilities, the appropriate guidance should be included in this annex.

11. The following is provided and should be included in the detailed Scope of Work for the AE's benefit: A computer program titled Life Cycle Costing in Design (LCCID) is available from the BLAST Support Office in Urbana, Illinois for a nominal fee. This computer program can be used for performing the economic calculations for ECIP and non-ECIP ECOs. The AE is encouraged to obtain and use this computer program. The BLAST Support Office can be contacted at 144 Mechanical Engineering Building, 1206 West Green Street, Urbana, Illinois 61801. The telephone number is (800) 842-5278.

12. Special Requirements - Distribution of submittal documents

(1) Four copies of all documents shall be mailed to:

Commander
U.S. Army Engineer District, Fort Worth
819 Taylor Street/P.O. Box 17300
ATTN: CESWF-ED-M/Richard Champagne
Fort Worth, TX 76102-0300

(2) Seven copies of all documents shall be mailed to:

Commander
DA, HQ, Fort Sam Houston
ATTN: DEH-ESB (Mr. Kaya Cibildak)
Fort Sam Houston, TX 78234-5000

ANNEX C

REQUIRED DD FORM 1391 DATA

To facilitate ECIP project approval, the following supplemental data shall be provided:

a. In title block, clearly identify projects as "ECIP."

b. Complete description of each item of work to be accomplished including quantity, square footage, etc.

c. A comprehensive listing of buildings, zones, or areas including building numbers, square foot floor areas, designated temporary or permanent, and usage.

d. List references, assumptions and provide calculations to support dollar and energy savings, and indicate any added costs.

(1) If a specific building, zone, or area is used for sample calculations, identify building, zone or area, category, orientation, square footage floor area, window and wall area for each exposure.

(2) Identify weather data source.

(3) Identify infiltration assumptions before and after improvements.

(4) Include source of expertise and demonstrate savings claimed. Identify any special or critical environmental conditions such as pressure relationships, exhaust or outside air quantities, temperatures, humidity, etc.

e. Claims for boiler efficiency improvements must identify data to support present properly adjusted boiler operation and future expected efficiency. If full replacement of boilers is indicated, explain rejection of alternatives such as replace burners, nonfunctioning controls, etc. Assessment of the complete existing installation is required to make accurate determinations of required retrofit actions.

f. Lighting retrofit projects must identify number and type of fixtures, and wattage of each fixture being deleted and installed. New lighting shall be only of the level to meet current criteria. Lamp changes in existing fixtures is not considered an ECIP type project.

g. An ECIP life cycle cost analysis summary sheet as shown in the ECIP Guidance shall be provided for the complete project and for each discrete part included in the project. The

SIR is applicable to all segments of the project. Supporting documentation consisting of basic engineering and economic calculations showing how savings were determined shall be included.

h. The DD Form 1391 face sheet shall include, for the complete project, the annual dollar and MBTU savings, SIR, simple amortization period and a statement attesting that all buildings and retrofit actions will be in active use throughout the amortization period.

i. The calendar year in which the cost was calculated shall be clearly shown on the DD Form 1391.

j. For each temporary building included in the project, separate documentation is required showing (1) a minimum 10-year continuing need, based on the installation's annual real property utilization survey, for active building retention after retrofit, (2) the specific retrofit action applicable, and (3) an economic analysis supporting the specific retrofit.

k. Nonappropriated funded facilities will not be included in an ECIP project without an accompanying statement certifying that utility costs are not reimbursable.

l. Any requirements required by ECIP guidance dated 4 November 1992 and revisions thereto. Note that unescalated costs/savings are to be used in the economic analyses.

m. The five digit category code number for all ECIP projects developed under this scope of work is 80000.

ANNEX D

EXECUTIVE SUMMARY GUIDELINE

1. Introduction.

2. Building Data (types, similar facilities, sizes, etc.).

3. Present Energy Consumption.

   o Total Annual Energy Used.

   o Source Energy Consumption.

     Electricity - KWH, Dollars, BTU
     Fuel Oil - GALS, Dollars, BTU
     Natural Gas - THERMS, Dollars, BTU
     Propane - GALS, Dollars, BTU
     Other - QTY, Dollars, BTU

   o Energy Consumption by Systems.

4. Historical Energy Consumption.

5. Energy Conservation Analysis.

   o ECOs Investigated.

   o ECOs Recommended.

   o ECOs Rejected. (Provide economics or reasons)

   o ECIP Projects Developed. (Provide list)*

   o Non-ECIP Projects Developed. (Provide list)*

   o Operational or Policy Change Recommendations.

   * Include the following data from the life cycle cost analysis summary sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR and the analysis date. For all programmed projects also include the year in which it is programmed and the programmed year cost. Show the simple payback

period for all ECOs.

6. Energy and Cost Savings.

   o Total Potential Energy and Cost Savings.

   o Percentage of Energy Conserved.

   o Energy Use and Cost Before and After the Energy Conservation Opportunities are Implemented.

7. Energy Plan.

   o Project Breakouts with Total Cost and SIR.

   o Schedule of Energy Conservation Project Implementation.

G - SYMBOLS, ABBREVIATIONS AND CONVERSION FACTORS

SYMBOLS AND ABBREVIATIONS

$	-	Dollar
BLDG	-	Building
BTU	-	British Thermal Unit
DX	-	Direct Expansion
EER	-	Energy Efficiency Ratio
EFL	-	Equivalent Full Load Hours
HP	-	Horse Power
HR	-	Hour
HVAC	-	Heating, Ventilation and Air Conditioning
HW	-	Hot Water
IES	-	Illuminating Engineering Society
KW	-	Kilo Watt
KWH	-	Kilo Watt Hour
MBH	-	1000 British Thermal Units
MMBTU	-	1,000,000 British Thermal Units
KCF	-	1000 Cubic Feet
MCF	-	1,000,000 Cubic Feet
RTU	-	Rooftop Unit
SF	-	Square Feet
W	-	Watts
YR		Year
°F	-	Degree Fahrenheit

CONVERSION FACTORS

1 KWH	=	.003413 MBTU
1 KCF	=	1.031 MBTU

H - SAMPLE SOFTWARE CALCULATIONS AND OUTPUT DESCRIPTIONS

SIMPCALC OUTPUT

NOTES BY SYMBOL "O":

1. Annual KWH Electrical Savings
2. Annual KW Demand Savings
3. Annual MCF Gas Savings

Form	Facility	ECRM Desc.	Page	KWH/Yr	KW	MCF/yr	mmBtu/Yr	$/Yr	Imp.Cost	PayBack
C7-01	BLDG 0044 SNACK BAR	Prog Thermostat	1	472	.00	3.5	5.2	29	122	4.2
		*** SUB-TOTAL ***		472	.00	3.5	5.2	29	122	4.2
	** GRAND TOTAL **			472	.00	3.5	5.2	29	122	4.2
				1	2	3				

C7-001 Programmable Thermostats - BLDG 0044 SNACK BAR (G)

Cost Source: means cost estimating

Description: Install night setback/setup thermostat.

A)	.15	BTU/hr-ft-F	U-Value of Walls
B)	0	Sq.Ft.	Wall Area (includes windows and doors)
C)	.05	BTU/hr-ft-F	U-Value of Roof
D)	2074	Sq.Ft.	Roof Area
E)	70	Degree/F	Heating Season Thermostat Setpoint
F)	55	Degree/F	Heating Season Thermostat Setback Setpoint
G)	1800	Hours/yr	Heating Season Setback Hours = 12 Hrs/day x 150 Days/yr
H)	74	Degree/F	Cooling Season Thermostat Setpoint
I)	90	Degree/F	Cooling Season Thermostat Setback Setpoint
J)	2400	Hours/yr	Cooling Season Setback Hours = 12 Hrs/day x 200 Days/yr
K)	.7500		Heating Equipment Efficiency (Table 2)
L) $	3.41	/MCF	Cost per MCF
M)	8.57	BTUH/Watt	EER of Air Conditioning Unit (Table 1)
N) $	.0360	/KWH	Cost per KWH - Summer
O) $	122		Installed Cost = 1 Thermostats x $ 122/stat
P)	104	BTU/hf-F	Total Envelope UA-Value
Q)	2.8	mmBTU/yr	Heating Load Reduction
R) $	12		Heating Cost Reduction
S)	4.0	mmBTU/yr	Cooling Load Reduction
T) $	17	/year	Cooling Cost Reduction
U) $	29	/year	Annual Cost Savings
V)	4.2	years	Simple Payback

SIMPACALC CALCULATIONS

(See Attached)

SIMPLIFIED CALCULATION FORM

High Efficiency HVAC Unit (electric/gas to electric/gas)

Description of ECRM (Data needed: use of space, age of units)
Cost:

Data needed for calculations:

A)______ *Tons* Cooling Tonnage to be Replaced

B)______ *BTU/hr* Natural Gas Heating to be Replaced

C)______ *Hr/yr* Cooling Equivalent Full Load Operating Hours

D)______ *Hr/yr* Heating Equivalent Full Load Opeating Hours

E)______ *Mo/yr* Number of Cooling Months

F)______ *KW/ton* Cooling Performance of Existing Unit

G)______ *KW/ton* Cooling Performance of Proposed Unit

H)______ *%* Heating Efficiency of Existing Furnace

Data needed for calculations (con't):

I)______%	Heating Efficiency of New Furnace
J)$______/KWH	Cost of Electricity, Summer
K)$______/KW-Mo	Cost of Demand (KW), Summer
L)$______/MCF	Cost of Natural Gas
M)$______	Installed Cost of Unit(s)

Calculation:

N) Cooling Demand Reduction = A( ) x (F( ) - G( ))

= [KW]

O) Annual Cooling Energy Savings = N( ) x C( )

= [KWH/yr]

P) Cooling Demand Savings = N( ) x E( )

= [KW-Mo/yr]

Q) Cooling Cost Savings = O( ) x J( ) + P( ) x K( )

= [$ /yr]

R) Hourly Energy Reduction = B x (1 - H( ) / I( ))

= BTU/hr

S) Heating Fuel Saved = R( ) x D( ) / 1,030,000 BTU/MCF

= MCF/yr

T) Heating Cost Savings = S( ) x L( )

= $ /yr

U) Simple Payback = M / (Q( ) + T( ))

= yrs

SIMPLIFIED CALCULATION FORM

Time Clock Control of HVAC (electric cool/gas heat)

Description of ECRM (Data needed: area served, condition/performance of unit)
Cost:

Data needed for calculations:

A)______	*Tons*	Average Cooling Unit Tonnage
B)______	*Hrs/yr*	Annual Cooling Operating Hrs that Unit Will Be Shut Off (not full load equivalent hours)
C)______	*KW/ton*	System Performance
D)______	*Hrs/yr*	Annual Heating Operating Hrs that Unit Will Be Shut Off
E)______	*MBTU/hr*	Average Heating Unit Load
F)______	*%*	Heating Efficiency
G)$______	*/KWH*	Electricity Cost per KWH
H)$______	*/MCF*	Natural Gas Cost per MCF
I)$______		Implementation Cost

Calculation:

J) Annual Cooling Savings	=	A( ) x B( ) x C( )
	=	KWH/yr
K) Annual Heating Savings	=	E( ) x D( ) / F( ) x 100 / 1,030 MBTU/MCF
	=	MCF/yr
L) Annual Cost Savings	=	J( ) x G( ) + K( ) x H( )
	=	$ /yr
M) Simple Payback	=	I( ) / L( )
	=	yrs

SIMPLIFIED CALCULATION FORM

High Efficiency DHW Heater (gas to gas)

Description of ECRM (Data needed: area served, number of users, description of present unit)
Cost:

Data needed for calculations:

A)______	*Gallons/ person-day*	Daily per capita Hot Water Consumption
B)______	*Persons*	Number of Persons
C)______	*Days/yr*	Occupancy Days per Year
D)______	*°F*	Hot Water Temperature
E)______	*%*	Efficiency of Present Unit
F)______	*%*	Efficiency on Proposed Unit
G)______	*MMBTU/yr*	Annual Standby Loss
H)______	*%*	Reduction in Standby Loss with New Unit (Default = 50%)

Data needed for calculations (con't): I)$______/MCF   Fuel Cost J)$______   Installed Cost of Unit(s) (including Design)

Calculations:

K) Water Heating Required = 8.33 x A( ) x B( ) x C( ) x (D( ) - 70°F) / 1,000,000 BTU/MMBTU

= [MMBTU/yr]

L) Present Fuel Use = (K( ) + G( )) / (E( ) x 100 / 1.03 MMBTU/MCF)

= [MCF/yr]

M) Equivalent Fuel in New Heater = [K( ) + G( ) x (1 - H( )/100)] / (F( ) x 100 / 1.03 MMBTU/MCF)

= [MCF/yr]

N) Fuel Saved = L( ) - M( )

= [MCF/yr]

O) Operational Savings = N( ) x I( )

= [$ /yr]

P) Simple Payback = J( ) / O( )

= [yrs]

FLEX OUTPUT

NOTES BY SYMBOL "O":

1. Post Retrofit Annual KWH Lighting Consumption
2. Post Retrofit Lighting Demand
3. Post Retrofit Annual KWH Cooling Consumption
4. Existing Annual KWH Lighting Consumption
5. Existing Lighting Demand
6. Existing Annual KWH Cooling Consumption
7. Annual Maintenance Savings
8. Fixture type
9. Fixture count
10. Lamp count
11. Ballast count

```
==================================
| Whole Building Summary Report   |
==================================

Project: FT SAM HOUSTON EEAP
   File: H:\JOB\911099\12F\ELECT\FLEX\OUT\0044\BLD0044A.WBR
   Date: 10/16/1993

Lighting Annual           :      6610  kWh   1
Lighting Capacity         :     2.938  kW    2
Annual Cooling Effect     :      9322  kWh   3
Annual Heating Effect     :       944  kWh
Total Surveyed Floor Area:       2199  SqFt
Percent Survey Completed :     219900  %
Lighting Power Density    :     1.336  W/sqft

Costs     Initial    Energy    Maint.   Cooling   Heating     Total
-----    --------  --------  --------  --------  --------  --------
PVLCC  $     2117      8447       945     11595      -162     22942
AVLCC  $      156       622        70       853       -12      1688
```

```
====================================
| Whole Building Summary Report    |
====================================

Project: FT SAM HOUSTON EEAP
   File: H:\JOB\911099\12F\ELECT\FLEX\OUT\0044\BLD0044B.WBR
   Date: 10/16/1993

Lighting Annual            :    10101  kWh   4
Lighting Capacity          :    4.490  kW    5
Annual Cooling Effect      :    14240  kWh   6
Annual Heating Effect      :     1443  kWh
Total Surveyed Floor Area:       2199  SqFt
Percent Survey Completed :        220  %
Lighting Power Density     :    2.042  W/sqft

Costs    Initial    Energy    Maint.   Cooling   Heating     Total
-----  ---------  --------  --------  --------  --------  --------
PVLCC $        0     12909      1395     17694      -248     31750
AVLCC $        0       950       103      1302       -18      2336
```

Project Name (*=Base)	Annual Energy kWh	Net Present Value $	Present Value Total LCC $	Annual Value Total LCC $	Annual Energy Savings kWh	Savings Invest. Ratio (SIR)	Levelized Energy Cost cnts/kWh	Total Initial Cost $	Present Value Maint LCC $	Present Value Energy LCC $	Annual Value Maint LCC $	Annual Value Energy LCC $
BLD0044A	6610	8808	22942	1688	3492	4.160	3.515	2117	945	19880	70	1463
*BLD0044B	10101	0	31750	2336	0	0.000	0.000	0	1395	30355	103	2234

7

Project Description: FT SAM HOUSTON EEAP

File Names	Case Description
BLD0044A	POST RETROFIT CONDITIONS
BLD0044B	EXISTING CONDITIONS

| Lighting Level Comparison Report |

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\0044\BLD0044A.LLR
Date: 10/16/1993

Room Foot Candles	MAX	MIN	AVG	SDEV	MAX Room	MIN Room
Calculated	44.7	5.3	23.3	16.77	5-kitchen	1-storage
Measured	45.7	0.0	16.8	19.06	5-kitchen	2-Corr
Required	50.0	5.0	26.0	22.75	3-stor	1-storage

Foot Candle Comparison	MAX	MIN	AVG	SDEV	MAX Room	MIN Room
Calc - Req.	24.5	-20.2	-2.7	17.07	4-dining	3-stor
Meas - Req.	18.6	-50.0	-9.2	27.05	4-dining	3-stor

```
===================================
| Lighting System Survey Summary  |
| One Page for Each Defined System |
===================================

   ject: FT SAM HOUSTON EEAP
   ile: H:\JOB\911099\12F\ELECT\FLEX\OUT\0044\BLD0044A.LSR
   ate: 10/16/1993

System Number:    1       Descrip: suspended wrap  8
==================================================================

 Rooms Served:        1
   Floor Area:      272   SqFt
  Possible kW:    0.126
  Working  kW:    0.126
 Capacity  kW:    0.126
     Lighting:      283   Annual kWh
      Heating:       40   Annual kWh
      Cooling:      401   Annual kWh
Op Hours/Year:     2250   Annual Hrs
Relamp Method:     Spot
Relamp Time  :    142.1   Months
Power Density:    0.462   Watts/SqFt
```

Equipment	Fixtures 9	Lamps 10	Ballasts 11
Possible	2	4	2.0
Working	2	4	2.0
Capacity	2	4	2.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	361	35	505	-7	976
AVLCC	$	27	3	37	-1	72

```
System Number:    2       Descrip: 2x4 lay-in
==================================================================

   ms Served:         2
   loor Area:      1556   SqFt
   ossible kW:    0.628
  Working  kW:    0.628
 Capacity  kW:    0.628
     Lighting:     1413   Annual kWh
      Heating:      202   Annual kWh
      Cooling:     2004   Annual kWh
Op Hours/Year:     2250   Annual Hrs
Relamp Method:     Spot
Relamp Time  :    142.1   Months
Power Density:    0.404   Watts/SqFt
```

Equipment	Fixtures	Lamps	Ballasts
Possible	10	20	10.0
Working	10	20	10.0
Capacity	10	20	10.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs		Energy	Maint.	Cooling	Heating	Total
PVLCC	$	1806	177	2524	-35	4882
AVLCC	$	133	13	186	-3	359

System Number: 3 Descrip: 2x4 recessed, acrylic

Rooms Served:	2	
Floor Area:	371	SqFt
Possible kW:	0.928	
Working kW:	0.899	
Capacity kW:	0.928	
Lighting:	2088	Annual kWh
Heating:	298	Annual kWh
Cooling:	2910	Annual kWh
Op Hours/Year:	2250	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	142.1	Months
Power Density:	2.423	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	8	32	8.0
Working	8	31	7.0
Capacity	8	32	8.0
Disconnected	0	0	0.0
Broken/Burned	0	1	0.0

Costs	Energy	Maint.	Cooling	Heating	Total
PVLCC $	2668	221	3520	-51	6782
AVLCC $	196	16	259	-4	499

System Number: 4 Descrip: 8' industrial w/ 1/2'plastic

Rooms Served:	1	
Floor Area:	1360	SqFt
Possible kW:	1.256	
Working kW:	1.256	
Capacity kW:	1.256	
Lighting:	2826	Annual kWh
Heating:	404	Annual kWh
Cooling:	4007	Annual kWh
Op Hours/Year:	2250	Annual Hrs
Relamp Method:	Spot	
Relamp Time :	142.1	Months
Power Density:	0.924	Watts/SqFt

Equipment	Fixtures	Lamps	Ballasts
Possible	20	40	20.0
Working	20	40	20.0
Capacity	20	40	20.0
Disconnected	0	0	0.0
Broken/Burned	0	0	0.0

Costs	Energy	Maint.	Cooling	Heating	Total
PVLCC $	3612	512	5047	-69	10302
AVLCC $	266	38	371	-5	758

Room-By-Room Summary Report

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\0044\BLD0044A.RRR
Date: 10/16/1993

Room Name	Floor	#	*	Total Area	#Pr	SYSTEM1 Name	Work Watts	Pot. Watts	Watt sqft	SYSTEM2 Name	Work Watts	Pot. Watts	Watt sqft	SYSTEM3 Name	Work Watts	Pot. Watts	Watt sqft	Work Watts	Pot. Watts	Watt sqft	Meas. FootC	Calc. FootC	Req. FootC
1-storage	1	1	*	272	1	suspended	126	126	0.46									126	126	0.46	14.5	5.3	5.0
2-Corr	1	1		196	2	2x4 lay-in	126	126	0.64									126	126	0.64	0.0	7.1	20.0
3-stor	1	1		147	1	2x4 recess	319	348	2.37									319	348	2.37	0.0	29.8	50.0
4-dining	1	1		1360	15	2x4 lay-in	502	502	0.37	8' industr	1256	1256	0.92					1758	1758	1.29	23.6	29.5	5.0
5-kitchen	1	1		224	1	2x4 recess	580	580	2.59									580	580	2.59	45.7	44.7	50.0

Total Rooms : 5
Total Area SqFt : 2199
Total People : 20
Total Working kW : 2.909
Total Potential kW : 2.938
Power Density W/sqft : 1.336

Room-By-Room Summary Report

Project: FT SAM HOUSTON EEAP
File: H:\JOB\911099\12F\ELECT\FLEX\OUT\0044\BLD0044A.RRR
Date: 10/16/1993

Room Name	Floor	#	*	Total Area	#Pr	SYSTEM1 Name	Work Watts	Pot. Watts	Watt sqft	SYSTEM2 Name	Work Watts	Pot. Watts	Watt sqft	SYSTEM3 Name	Work Watts	Pot. Watts	Watt sqft	Work Watts	Pot. Watts	Watt sqft	Meas. FootC	Calc. FootC	Req. FootC
1-storage	1	1	*	272	1	suspended	126	126	0.46									126	126	0.46	14.5	5.3	5.0
2-Corr	1	1		196	2	2x4 lay-in	126	126	0.64									126	126	0.64	0.0	7.1	20.0
3-stor	1	1		147	1	2x4 recess	319	348	2.37									319	348	2.37	0.0	29.8	50.0
4-dining	1	1		1360	15	2x4 lay-in	502	502	0.37	8' industr	1256	1256	0.92					1758	1758	1.29	23.6	29.5	5.0
5-kitchen	1	1		224	1	2x4 recess	580	580	2.59									580	580	2.59	45.7	44.7	50.0

Total Rooms : 5
Total Area SqFt : 2199
Total People : 20
Total Working kW : 2.909
Total Potential kW : 2.938
Power Density W/sqft : 1.336

TRACE OUTPUT

NOTES BY SYMBOL "O:

1. Alternative 1 - Annual KWH Electrical Consumption
2. Alternative 1 - Peak Demand
3. Alternative 1 - Annual Gas Consumption
4. Alternative 2 - Annual KWH Electrical Consumption
5. Alternative 2 - Peak Demand
6. Alternative 2 - Annual Gas Consumption

MONTHLY ENERGY CONSUMPTION - ALTERNATIVE 1

---------------------------------- M O N T H L Y   E N E R G Y   C O N S U M P T I O N ----------------------------------

Month	ELEC On Peak (kWh)	DEMAND On Peak (kW)	GAS On Peak (Therm)	WATER (1000 Gl)	GAS DMND On Peak (Thrm/hr)
Jan	67,572	194	1,307	36	6
Feb	59,019	192	1,204	31	5
March	80,990	208	1,065	67	2
April	85,713	218	930	88	2
May	97,768	229	858	113	1
June	102,010	235	778	126	1
July	109,890	242	796	142	1
Aug	112,441	246	798	145	1
Sept	98,607	239	837	118	1
Oct	86,017	220	1,027	81	2
Nov	76,567	209	1,032	57	2
Dec	66,386	196	1,275	32	5
Total	1 1,042,981	2 246	3 11,908	1,036	6

Building Energy Consumption = 133,290 (Btu/Sq Ft/Year) Floor Area = 35,640 (Sq Ft)
Source Energy Consumption = 334,837 (Btu/Sq Ft/Year)

EQUIPMENT ENERGY CONSUMPTION - ALTERNATIVE 1

E Q U I P M E N T   E N E R G Y   C O N S U M P T I O N

Ref Num	Equip Code	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
0	LIGHTS													
	ELEC	31114	28120	32183	29938	31648	31007	30579	32183	29938	31648	29938	30579	368,874
	PK	89.1	89.1	89.1	89.1	89.1	89.1	89.1	89.1	89.1	89.1	89.1	89.1	89.1
1	MISC LD													
	ELEC	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	MISC LD													
	GAS	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	MISC LD													
	OIL	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	MISC LD													
	P STEAM	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	MISC LD													
	P HOTH2O	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	MISC LD													
	P CHILL	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	EQ1131L		WTR-CLD COND COMP W-EVAP COND >30 TONS											
	ELEC	7917	6886	14472	19250	24873	27467	31221	31793	26010	17286	12426	7017	226,617
	PK	49.6	49.5	58.3	64.6	71.9	75.2	79.5	81.6	79.7	66.3	59.1	49.3	81.6
1	EQ5105		COOLING TOWER											
	ELEC	4204	2071	8173	9824	11605	12976	14491	14511	11933	9456	8760	4300	112,306
	PK	20.5	16.4	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5
1	EQ5105		COOLING TOWER											
	WATER	34	29	65	85	111	123	139	142	115	78	54	30	1,006
	PK	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.4
1	EQ5302		CONTROLS											
	ELEC	29	25	46	48	57	63	71	71	58	46	43	26	583
	PK	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2	EQ1100S		AIR-CLD RECIP 25-45 TONS											
	ELEC	16615	15000	18039	18458	20788	21734	24143	24546	21847	19193	17573	16747	234,684
	PK	26.2	26.4	28.5	31.5	35.2	38.0	40.9	41.4	37.6	32.0	28.4	26.4	41.4
	EQ5200		CONDENSER FANS											

EQUIPMENT ENERGY CONSUMPTION - ALTERNATIVE 1

	ELEC	671	575	1054	1400	1776	1968	2363	2315	2026	1366	1034	696	17,243
	PK	1.5	1.4	2.7	3.1	3.3	3.5	4.9	4.9	3.6	3.2	2.6	1.6	4.9
2	EQ5001		CHILLED WATER PUMP C.V.											
	ELEC	2219	2004	2219	2148	2219	2148	2219	2219	2148	2219	2148	2219	26,129
	PK	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
2	EQ5303		CONTROLS											
	ELEC	223	202	223	216	223	216	223	223	216	223	216	223	2,628
	PK	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
1	EQ2002		GAS FIRE TUBE STEAM											
	GAS	1307	1204	1065	930	858	778	796	798	837	1027	1032	1275	11,908
	PK	6.3	5.3	2.0	1.6	1.4	1.4	1.4	1.4	1.3	1.8	1.9	4.5	6.3
1	EQ5020		HEAT WATER CIRC. PUMP C.V.											
	ELEC	3699	3341	3699	3579	3699	3579	3699	3699	3579	3699	3579	3699	43,549
	PK	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
1	EQ5240		BOILER FORCED DRAFT FAN											
	ELEC	486	439	486	470	486	470	486	486	470	486	470	486	5,720
	PK	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
1	EQ5307		BOILER CONTROLS											
	ELEC	372	336	372	360	372	360	372	372	360	372	360	372	4,380
	PK	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	EQ5061		CONDENSATE RETURN PUMP											
	ELEC	23	21	23	22	23	22	23	23	22	23	22	23	269
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	EQ5406		MAKE-UP WATER											
	WATER	3	2	3	2	3	2	3	3	2	3	2	3	30
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

UTILITY PEAK CHECKSUMS - ALTERNATIVE 1

-------------------------------------- U T I L I T Y   P E A K   C H E C K S U M S --------------------------------------

Utility ELECTRIC DEMAND

Peak Value 246.0 (kW)
Yearly Time of Peak 16 (hr) 8 (mo)

Hour 16 Month 8

Eqp. Ref. Num.	Equipment Code Name	Equipment Description	Utility Demand (kW)	Percnt Of Tot (%)
Cooling Equipment				
1	EQ1131L	WTR-CLD COND COMP W-EVAP COND >30 TONS	101.7	41.34
2	EQ1100S	AIR-CLD RECIP 25-45 TONS	49.0	19.94
Sub Total			150.7	61.28
Heating Equipment				
1	EQ2002	GAS FIRE TUBE STEAM	6.2	2.50
Sub Total			6.2	2.50
Sub Total			0.0	0.00
Total			0.0	0.00
Miscellaneous				
Lights			89.1	36.22
Base Utilities			0.0	0.00
Misc Equipment			0.0	0.00
Sub Total			89.1	36.22
Grand Total			246.0	100.00

MONTHLY ENERGY CONSUMPTION - ALTERNATIVE 2

M O N T H L Y   E N E R G Y   C O N S U M P T I O N

Month	ELEC On Peak (kWh)	DEMAND On Peak (kW)	GAS On Peak (Therm)	WATER (1000 Gl)	GAS DMND On Peak (Thrm/hr)
Jan	58,679	194	769	35	6
Feb	50,416	192	692	30	5
March	69,034	208	542	64	2
April	71,759	218	397	82	2
May	81,052	229	306	105	1
June	82,624	235	226	115	1
July	84,565	242	169	125	1
Aug	89,972	246	217	132	1
Sept	79,775	240	290	108	1
Oct	73,049	221	486	76	2
Nov	64,568	210	509	53	2
Dec	56,222	197	699	31	4
Total	4 861,716	5 246	6 5,302	956	6

Building Energy Consumption = 97,397 (Btu/Sq Ft/Year) Floor Area = 35,640 (Sq Ft)
Source Energy Consumption = 263,246 (Btu/Sq Ft/Year)

EQUIPMENT ENERGY CONSUMPTION - ALTERNATIVE 2

------------------------------- E Q U I P M E N T   E N E R G Y   C O N S U M P T I O N -------------------------------

Ref Num	Equip Code	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
0	LIGHTS													
	ELEC	31114	28120	32183	29938	31648	31007	30579	32183	29938	31648	29938	30579	368,874
	PK	89.1	89.1	89.1	89.1	89.1	89.1	89.1	89.1	89.1	89.1	89.1	89.1	89.1
1	MISC LD													
	ELEC	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	MISC LD													
	GAS	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	MISC LD													
	OIL	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	MISC LD													
	P STEAM	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	MISC LD													
	P HOTH2O	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	MISC LD													
	P CHILL	0	0	0	0	0	0	0	0	0	0	0	0	0
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	EQ1131L	WTR-CLD COND COMP W-EVAP COND >30 TONS												
	ELEC	7657	6629	13908	17844	22738	24572	26442	28097	23323	16356	11930	6832	206,328
	PK	49.6	49.5	58.3	64.6	76.5	82.6	85.5	85.9	81.5	66.3	59.0	49.3	85.9
1	EQ5105	COOLING TOWER												
	ELEC	4430	2010	7104	8187	8678	8514	8351	8842	8187	8167	7737	4081	84,287
	PK	20.5	16.4	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5
1	EQ5105	COOLING TOWER												
	WATER	33	28	62	80	104	114	124	131	106	75	52	29	939
	PK	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.4
1	EQ5302	CONTROLS												
	ELEC	28	23	41	40	42	42	41	43	40	40	38	27	445
	PK	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2	EQ1100S	AIR-CLD RECIP 25-45 TONS												
	ELEC	9750	8693	11021	11050	12897	13625	14429	15581	13447	11877	10472	9604	142,446
	PK	26.2	26.4	28.5	31.5	35.2	38.0	41.1	41.8	38.2	32.5	28.9	26.7	41.8
	EQ5200	CONDENSER FANS												

EQUIPMENT ENERGY CONSUMPTION - ALTERNATIVE 2

	ELEC	439	357	701	950	1157	1271	1458	1512	1299	960	679	429	11,212
	PK	1.5	1.4	2.7	3.1	3.3	3.5	4.9	4.9	3.7	3.2	2.7	1.6	4.9
2	EQ5001		CHILLED WATER PUMP C.V.											
	ELEC	1241	1122	1289	1193	1265	1241	1217	1289	1193	1265	1193	1217	14,723
	PK	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
2	EQ5303		CONTROLS											
	ELEC	125	113	130	120	127	125	122	130	120	127	120	122	1,481
	PK	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
1	EQ2002		GAS FIRE TUBE STEAM											
	GAS	769	692	542	397	306	226	169	217	290	486	509	699	5,302
	PK	6.3	5.4	2.1	1.5	1.4	1.2	1.1	1.2	1.3	1.8	2.0	4.3	6.3
1	EQ5020		HEAT WATER CIRC. PUMP C.V.											
	ELEC	3147	2704	2148	1969	2018	1800	1556	1854	1800	2108	1989	2689	25,781
	PK	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
1	EQ5240		BOILER FORCED DRAFT FAN											
	ELEC	413	355	282	259	265	236	204	244	236	277	261	353	3,386
	PK	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
1	EQ5307		BOILER CONTROLS											
	ELEC	317	272	216	198	203	181	157	186	181	212	200	271	2,593
	PK	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	EQ5061		CONDENSATE RETURN PUMP											
	ELEC	19	17	13	12	12	11	10	11	11	13	12	17	159
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	EQ5406		MAKE-UP WATER											
	WATER	2	2	1	1	1	1	1	1	1	1	1	2	18
	PK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

UTILITY PEAK CHECKSUMS - ALTERNATIVE 2

------------------------------------- U T I L I T Y   P E A K   C H E C K S U M S -------------------------------------

Utility ELECTRIC DEMAND

Peak Value 246.4 (kW)
Yearly Time of Peak 16 (hr) 8 (mo)

Hour 16 Month 8

Eqp. Ref. Num.	Equipment Code Name	Equipment Description	Utility Demand (kW)	Percnt Of Tot (%)
Cooling Equipment				
1	EQ1131L	WTR-CLD COND COMP W-EVAP COND >30 TONS	101.7	41.29
2	EQ1100S	AIR-CLD RECIP 25-45 TONS	49.4	20.05
Sub Total			151.1	61.33
Heating Equipment				
1	EQ2002	GAS FIRE TUBE STEAM	6.2	2.50
Sub Total			6.2	2.50
Sub Total			0.0	0.00
Sub Total			0.0	0.00
Miscellaneous				
Lights			89.1	36.17
Base Utilities			0.0	0.00
Misc Equipment			0.0	0.00
Sub Total			89.1	36.17
Grand Total			246.4	100.00

LOTUS (BIN METHOD) OUTPUT

NOTES BY SYMBOL "O":

1. Modified Bin Method Table
2. Assumptions
3. Equipment Efficiencies to Determine Electrical Usage
4. Existing Conditions With No Supply Air Make-Up to Hood
5. Post Retrofit Conditions with New Supply Air Make-Up Hood

MODIFIED BIN METHOD CALCULATIONS

REFER TO ASHRAE 1993 FUNDAMENTALS

	BLDG. NO.				44	368	407	1350	1387	1462	2399	2652
	TIME OF OPERATION				6:00A 1:30P	6:00A 2:00P	7A–10P 7A–2P	4:00A 8:30P	10:00A 9:00P	9A–8:30P 9A–10:30P	5:00A 7:30P	10:00A 7:00P
	DAYS/WEEK				5	5	4 , 3	6	5	5 , 2	7	4
	DB RANGE	MID PT.	MC WB	HUMID RATIO	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.	HRS /YR.
	100/104	102	74	0.0116	6.4	7.0	14.6	14.5	10.1	15.8	16.1	7.1
	95/99	97	74	0.0126	59.4	64.8	139.8	139.4	97.9	152.8	153.4	67.7
	90/94	92	74	0.0139	135.0	147.3	309.0	307.1	213.4	334.4	339.8	149.6
	85/89	87	73	0.0143	173.8	189.6	418.5	418.7	296.3	461.3	458.6	202.9
	80/84	82	72	0.0146	213.2	231.4	530.6	557.5	382.4	589.7	595.6	253.5
	75/79	77	70	0.0142	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	70/74	72	66	0.0123	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
①	65/69	67	61	0.0101	196.1	208.4	418.7	527.9	283.1	433.6	535.7	183.2
	60/64	62	56	0.0082	161.8	172.0	346.9	437.0	235.1	359.9	443.3	151.9
	55/59	57	51	0.0066	132.3	140.5	288.0	363.6	196.9	300.7	367.8	126.2
	50/54	52	47	0.0057	118.4	125.4	256.0	332.4	174.6	265.8	333.0	110.6
	45/49	47	43	0.0050	92.0	96.8	190.1	260.7	127.1	192.8	257.6	79.5
	40/44	42	38	0.0039	72.4	75.9	138.6	198.4	88.8	135.1	195.0	56.1
	35/39	37	34	0.0034	44.4	46.1	75.5	120.8	44.9	68.1	116.1	28.1
	30/34	32	29	0.0028	23.0	23.8	34.9	60.3	18.9	28.8	57.4	12.0
	25/29	27	25	0.0023	8.3	8.4	9.6	21.3	3.8	5.8	19.4	2.4
	20/24	22	20	0.0016	2.4	2.5	3.6	6.1	2.0	3.0	5.9	1.3
	15/19	17	15	0.0013	0.4	0.4	0.3	0.9	0.0	0.0	0.8	0.0
	10/14	12	10	0.0009	0.2	0.2	0.1	0.4	0.0	0.0	0.4	0.0

ASSUMPTIONS

1) SUMMER ROOM DESIGN: 78FDB, 50%RH
② 2) WINTER ROOM DESIGN: 70FDB, 40%RH
3) HUMIDITY RATIOS FOR THE SPACE BASED ON SUMMER & WINTER ROOM DESIGN TEMP.

③ EQUIPMENT:
SMALL AIR COOLED CHILLER (3–25 TONS): 8.57 BTU/WATT–H
LARGE AIR COOLED CHILLER (25–100 TONS): 8.63 BTU/WATT–H
SMALL WATER COOLED CHILLER (25–100 TONS): 11.11 BTU/WATT–H
LARGE WATER COOLED CHILLER (>100 TONS): 12.12 BTU/WATT–H

SYSTEM TYPES FOR ABOVE BUILDINGS

BUILDING NUMBER	SYSTEM TYPE
44	SMALL AIR COOLED
368	SMALL AIR COOLED
407	LARGE AIR COOLED
1350	LARGE WATER COOLED
1387	SMALL AIR COOLED
1462	LARGE AIR COOLED
2399	LARGE WATER COOLED
2652	LARGE AIR COOLED

ASSUME 40% CONDITIONED AIR IS EXHAUSTED
EXHAUST CFM=10FTx28FTx100FPM=28,000CFM
BUILDING 2399

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
11200	102	78	0.0116	0.0102	290304	75891	366195	16.1	5882010
11200	97	78	0.0126	0.0102	229824	130099	359923	153.4	55203221
11200	92	78	0.0139	0.0102	169344	200570	369914	339.8	125678146
11200	87	78	0.0143	0.0102	108864	222253	331117	458.6	151837748
11200	82	78	0.0146	0.0102	48384	238515	286899	595.6	170866405
11200	67	70	0.0101	0.0062	36288	211411	247699	535.7	132689365
11200	62	70	0.0082	0.0062	96768	108416	205184	443.3	90960632
11200	57	70	0.0066	0.0062	157248	21683	178931	367.8	65813132
11200	52	70	0.0057	0.0062	217728	27104	244832	333.0	90052270
11200	47	70	0.0050	0.0062	278208	65050	343258	257.6	114304781
11200	42	70	0.0039	0.0062	338688	124678	463366	195.0	119345808
11200	37	70	0.0034	0.0062	399168	151782	550950	116.1	107435328
11200	32	70	0.0027	0.0062	459648	189728	649376	57.4	75368202
11200	27	70	0.0023	0.0062	520128	211411	731539	19.4	41972062
11200	22	70	0.0017	0.0062	580608	243936	824544	5.9	47308212
11200	17	70	0.0013	0.0062	641088	265619	906707	0.8	17624121
11200	12	70	0.0009	0.0062	701568	287302	988870	0.4	5809614

TOTAL COOLING KBTU FOR THE YEAR 509468
TOTAL HEATING KBTU FOR THE YEAR 908684
EQUIPMENT 12.12 BTU/WATT COOLING KWH 59448

4

NOW 30% OF THE 11200 CFM IS EXHAUSTED
EXHAUST CFM=10FTx28FTx100FPM=28,000CFM
BUILDING 2399

CFM	DB	RM	HR OA	HR RM	SENS. BTUH	LATENT BTUH	TOTAL BTUH	HRS /YEAR	TOTAL BTU
3360	102	78	0.0116	0.0102	87091	22767	109859	16.1	1764603
3360	97	78	0.0126	0.0102	68947	39030	107977	153.4	16560966
3360	92	78	0.0139	0.0102	50803	60171	110974	339.8	37703444
3360	87	78	0.0143	0.0102	32659	66676	99335	458.6	45551324
3360	82	78	0.0146	0.0102	14515	71555	86070	595.6	51259921
3360	67	70	0.0101	0.0062	10886	63423	74310	535.7	39806810
3360	62	70	0.0082	0.0062	29030	32525	61555	443.3	27288190
3360	57	70	0.0066	0.0062	47174	6505	53679	367.8	19743940
3360	52	70	0.0057	0.0062	65318	8131	73450	333.0	27015681
3360	47	70	0.0050	0.0062	83462	19515	102977	257.6	34291434
3360	42	70	0.0039	0.0062	101606	37404	139010	195.0	35803743
3360	37	70	0.0034	0.0062	119750	45535	165285	116.1	32230598
3360	32	70	0.0027	0.0062	137894	56918	194813	57.4	22610461
3360	27	70	0.0023	0.0062	156038	63423	219462	19.4	12591618
3360	22	70	0.0017	0.0062	174182	73181	247363	5.9	14192464
3360	17	70	0.0013	0.0062	192326	79686	272012	0.8	5287236
3360	12	70	0.0009	0.0062	210470	86191	296661	0.4	1742884

TOTAL COOLING KBTU FOR THE YEAR 152840
TOTAL HEATING KBTU FOR THE YEAR 272605
EQUIPMENT 12.12 BTU/WATT COOLING KWH 17834

5

LOTUS (BIN METHOD) CALCULATIONS

(See Attached)

the monthly heating degree days for any location are well approximated by

$$DD_h(t_{bal}) = \sigma_m N^{3/2}\left[\frac{\theta}{2} + \frac{\ln(e^{-a\theta} + e^{a\theta})}{2a}\right] \quad (15)$$

where $a = 1.698\sqrt{\text{day/mo.}}$

For nine locations spanning most climatic zones of the United States, Erbs *et al.* (1983) verified that the annual heating degree days can be estimated with a maximum error of 315°F-days if this equation is used for each month. For cooling degree days, the largest error is 270°F-days. Such errors are quite acceptable, representing less than 5% of the total.

Example 1. Find the monthly heating degree-days for New York City, using the model of Erbs *et al.* (1983), given monthly averages of t_o as reproduced in column 2 of Table 1. Base the degree days on a balance temperature of 60°F.

The results are included in Table 1. Column 2 lists the given values of monthly average outdoor temperature, and N is the number of days in the month. Intermediate quantities are shown in columns 4 and 5, and $t_{o,yr}$ and σ_{yr} are shown at the bottom. Column 6 shows the monthly and annual results.

Table 2 contains degree-day data for several sites and monthly averaged outdoor temperatures needed for the algorithm used in the example. More complete tabulations of the latter are contained in Cinquemani *et al.* (1978) and in local climatological data summaries available from the National Climatic Data Center, Asheville, NC. Monthly degree-day data to the bases of 50°F, 55°F, 60°F, 65°F, and 70°F, as well as other climatic information for 209 U.S. and 14 Canadian cities, may be found in Appendix 3 to Balcomb *et al.* (1982).

Table 1 Degree-Day Calculation from Monthly Averaged Data

Month	$\bar{t}_o$, °F	N, day/mo.	σ_m, °F	σ, $\sqrt{\text{mo./day}}$	$DD_h(t_{bal})$, °F·day
January	32.2	31	3.65	1.37	864
Feburary	33.4	28	3.62	1.39	746
March	41.1	31	3.40	1.00	592
April	52.1	30	3.08	0.47	265
May	62.3	31	2.79	−0.15	67
June	71.6	30	2.52	−0.84	7
July	76.6	31	2.38	−1.26	2
August	74.9	31	2.41	−1.11	3
September	68.4	30	2.61	−0.59	16
October	58.7	31	2.88	0.08	123
November	46.4	30	3.22	0.72	391
December	35.5	31	3.56	1.24	762
$t_{o,yr}$	54.4			Sum	3837
σ_{yr}	15.8				

Note: Use Equation (15) to calculate $DD_h(t_{bal})$

BIN METHOD

For many applications, the degree-day method should not be used, even with the variable base method, because the heat loss coefficient K_{tot}, the efficiency η_h of the HVAC system, or the balance point temperature may not be sufficiently constant. The efficiency of a heat pump, for example, varies strongly with outdoor temperature; or the efficiency of the HVAC equipment may be affected indirectly by t_o when the efficiency varies with the load, a common situation for boilers and chillers. Furthermore, in most commercial buildings, the occupancy has a pronounced pattern, which affects heat gain, indoor temperature, and ventilation rate.

In such cases, a steady-state calculation can yield good results for the annual energy consumption, if different temperature intervals and time periods are evaluated separately. This approach is known as the bin method, because the consumption is calculated for several values of the outdoor temperature t_o and multiplied by the number of hours N_{bin} in the temperature interval (bin) centered around that temperature

$$Q_{bin} = N_{bin}\frac{K_{tot}}{\eta_h}[t_{bal} - t_o]^+ \quad (16)$$

The superscript plus sign indicates that only positive values are counted; no heating is needed when t_o is above t_{bal}. This equation is evaluated for each bin, and the total consumption is the sum of the Q_{bin} over all bins.

In the United States, the necessary data are widely available (ASHRAE 1984, USAF 1978). The bins are usually in 5°F increments and are often collected in three daily 8-h shifts. Mean coincident wet-bulb temperature data (for each dry-bulb bin) are used to calculate latent cooling loads from infiltration and ventilation. The bin method considers both occupied and unoccupied building conditions and gives credit for internal loads by adjusting the balance point. For example, a calculation could be performed for 42°F outdoors (representing all occurrences from 39.5 to 44.5°F) and with building operation during the midnight to 0800 shift. Since there are 23 5°F bins between −10 and 105°F and 3 8-h shifts, 69 separate operating points are calculated. For many applications, the number of calculations can be reduced. A residential heat pump (heating mode), for example, could be calculated for just the bins below 65°F without the three-shift breakdown. The data included in Table 3 are samples of annual totals for a few sites, but ASHRAE (1984) and USAF (1978) include monthly data and data further separated into time intervals during the day.

Table 2 Degree-Day and Monthly Average Temperatures for Various Locations

Site	Variable Base Heating Degree-Day, °F·days[a]					Monthly Average Outdoor Temperature, °F[b]											
	65	60	55	50	45	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Los Angeles, CA	1245	522	158	26	0	54.5	55.6	56.5	58.8	61.9	64.5	68.5	69.6	68.7	65.2	60.5	56.9
Denver, CO	6016	4723	3601	2653	1852	29.9	32.8	37.0	47.5	57.0	66.0	73.0	71.6	62.8	52.0	39.4	32.6
Miami, FL	206	54	8	0	0	67.2	67.8	71.3	75.0	78.0	81.0	82.3	82.9	81.7	77.8	72.2	68.3
Chicago, IL	6127	4952	3912	2998	2219	24.3	27.4	36.8	49.9	60.0	70.5	74.7	73.7	65.9	55.4	40.4	28.5
Albuquerque, NM	4292	3234	2330	1557	963	35.2	40.0	45.8	55.8	65.3	74.6	78.7	76.6	70.1	58.2	44.5	36.2
New York, NY	4909	3787	2806	1980	1311	32.2	33.4	41.1	52.1	62.3	71.6	76.6	74.9	68.4	58.7	47.4	35.5
Bismarck, ND	9044	7656	6425	5326	4374	8.2	13.5	25.1	43.0	54.4	63.8	70.8	69.2	57.5	46.8	28.9	15.6
Nashville, TN	3696	2758	1964	1338	852	38.3	41.0	48.7	60.1	68.5	76.6	79.6	78.5	72.0	60.9	48.4	40.4
Dallas/Ft. Worth, TX	2290	1544	949	526	250	45.4	49.4	55.8	66.4	73.8	81.6	85.7	85.8	78.2	68.0	55.9	48.2
Seattle, WA	4727	3269	2091	1194	602	39.7	43.5	45.5	50.4	56.5	61.3	65.7	64.9	60.6	54.2	45.7	42.0

[a]Source: NOAA (1973)
[b]Source: Cinquemani *et al.* (1978)

The Department of Energy has adopted test procedures (10 CFR 430, Appendix M, USGPO) to determine the effect of dynamic operations. The bin method uses these results for a specific heat pump to adjust the integrated capacity for the effect of part-load operation. Figure 4 compares the adjusted heat pump capacity to the building heat loss. This type of curve must be developed for each model heat pump as applied to an individual profile. The heat pump cycles on and off above the balance point temperature to meet the house load. This cycling can reduce performance depending on the part-load factor at a given temperature. The cycling capacity adjustment factors (ANSI/ASHRAE *Standard* 116-1983) used in this example to account for cycling degradation can be calculated from the equation in footnote a of Table 4.

Frosting and the necessary defrost cycle can reduce performance over steady-state conditions that do not include frosting. The effects of frosting and defrosting are already integrated into many (but not all) manufacturers' performance data. The example problem assumes that the manufacturers' data already accounts for the frosting/defrosting losses (as indicated by the characteristic notch of the capacity curve in Figure 4) and shows how to adjust an integrated performance curve for cycling losses. For those cases where the manufacturers' data on heating capacities do not include the effect of defrost cycles in the temperature range where they occur, steady-state, instant system capacities at a given outdoor temperature should be multiplied by a factor X_{int} to obtain the integrated heating capacity to be used in the annual energy calculation. The factor X_{int} is given by

$$
\begin{aligned}
X_{int} &= 1.0 \text{ for } t_o \geqslant 45\,^\circ\text{F} \\
&= 1.0 - (0.02)(45 - t_o) \text{ for } 40\,^\circ\text{F} \leqslant t_o < 45\,^\circ\text{F} \\
&= 0.95 - 0.00125\, t_o \text{ for } t_o < 40\,^\circ\text{F}
\end{aligned}
$$

where t_o is the outdoor dry-bulb temperature (Didion and Kelly 1979).

The total annual heating energy consumption used by the heat pump in this example is computed in Table 4 using bin weather data. Column F contains the capacity adjustment factor used to account for losses due to cycling.

Degree-Day Data from Bin Data

To calculate degree days from hourly bin data such as those in ASHRAE (1984), the base or balance temperature t_{bal} must first be determined. When t_{bal} is known, the following summation can be used on any time scale, either monthly or annually, or for several periods of a day on either a monthly or annual basis.

$$\text{DD}_h(t_{bal}) = \frac{1}{24}\left(\sum_{bins}(t_{bal} - t_{bin})^+ N_{bin}\right) \quad (17)$$

where

t_{bin} = temperature at center of bin
N_{bin} = number of hours in bin corresponding to t_{bin}

Cooling degree days are calculated analogously from

$$\text{DD}_c(t_{bal}) = \frac{1}{24}\left(\sum_{bins}(t_{bin} - t_{bal})^+ N_{bin}\right) \quad (18)$$

This method generally produces degree-day values slightly higher than published values from NOAA or the NCDC. This small but systematic deviation can be suppressed by ignoring degree days during the swing seasons when totals are less than a minimum, *e.g.*, 50 to 100°F-days per month. During such periods, thermal storage of daytime heat often makes nighttime heating unnecessary.

Modified Bin Method

Various refinements, such as the seasonal variation of solar gains, can be included in a bin calculation. If a separate calculation is done for each month, Q_{gain} could be based on the average solar heat gain of the month. The diurnal variation of solar gains can be accounted for by calculating the average solar gain for each of the hourly time periods of the bin method. If such a detailed calculation of solar gains is considered unnecessary, assume a linear correlation of monthly average solar heat gains with monthly average outdoor temperature t_o.

This procedure is illustrated in Figure 5(a) for the simplest case—a building with constant operating conditions every hour of the day and every day of the year (*i.e.*, t_i, K_{tot}, and nonsolar heat gains $q_{non\text{-}sol}$ are all constant). In this case, it suffices to calculate the daily average heating load q_{heat} for the peak winter day and the daily average cooling load q_{cool} on the peak summer day

$$q_{heat} = K_{tot}(t_i - t_{peak,\,winter}) - q_{non\text{-}sol} - q_{sol,\,winter} \quad (19)$$

and

$$q_{cool} = K_{tot}(t_i - t_{peak,\,summer}) - q_{non\text{-}sol} - q_{sol,\,summer} \quad (20)$$

where $t_{peak,\,winter}$ and $t_{peak,\,summer}$ are the design winter and summer outdoor temperatures and $q_{sol,\,winter}$ and $q_{sol,\,summer}$ are the corresponding daily average solar gains. The solar gains in Equations (19) and (20) are totals for all orientations of windows, roofs, and walls. Solar gains are calculated for each building element for summer and winter days and then summed to form the building total for the summer and winter endpoints of the load line in Figure 5 [see Knebel (1983) for details]. In the northern hemisphere, the summer month is usually taken as July and the winter month as January.

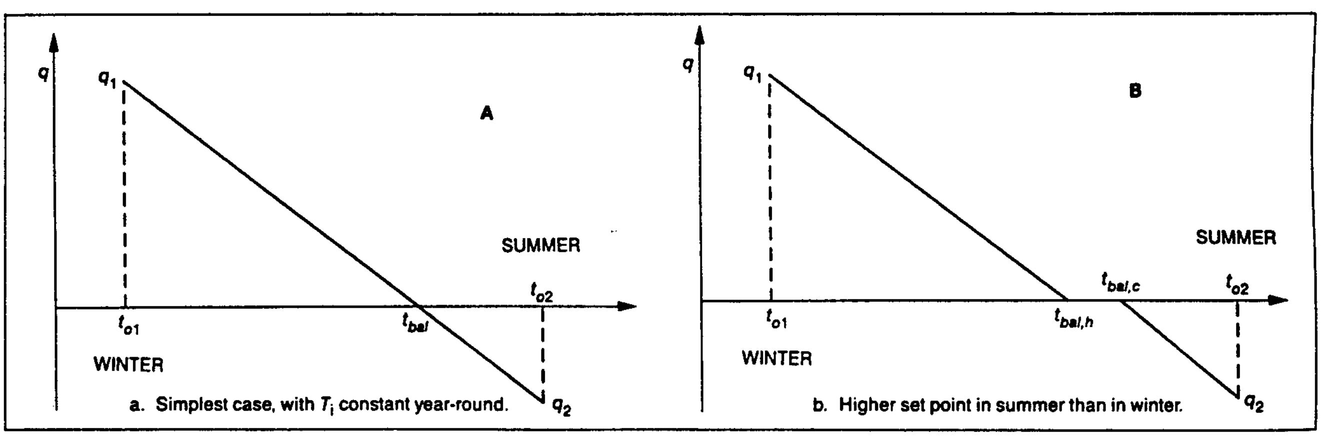

Fig. 5 Load as Function of Outdoor Temperature T_o (Ventilative cooling not shown.)

Energy Estimating Methods

Example 2. Estimate the energy requirements for a residence in Washington, D.C., with a design heat loss of 40,000 Btu/h at 53°F temperature difference. Assume a 3-ton heat pump, with characteristics given in Figure 4 and Table 4.

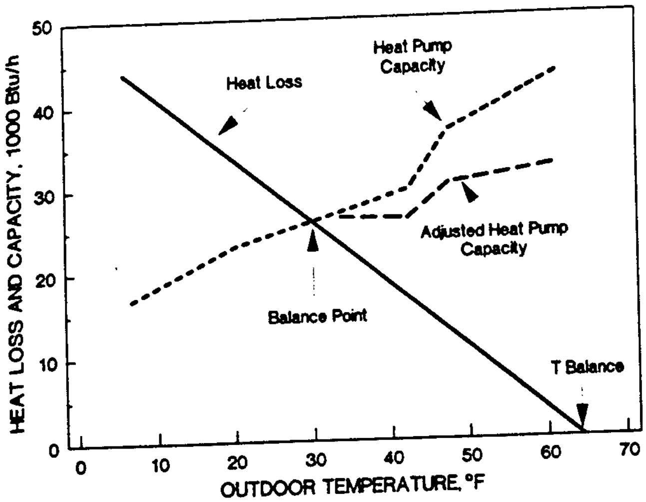

Fig. 4 Heat Pump Capacity versus Building Load

Solution: The design heat loss is based on no internal heat generation. To compute the heat pump system energy input, compute the net heat requirement of the space, *i.e.*, envelope loss minus internal heat generation. For this example, assume an average internal heat generation of 4280 Btu/h and a room temperature of 70°F. The net heat loss per degree and the heating/cooling balance temperature may be computed:

$$(HL/\Delta t) = (40{,}000/53) = 755 \text{ Btu/h}\cdot°\text{F}$$

$$t_{balance} = 70 - (4280/755) = 64.3°\text{F}$$

Table 4 is then computed resulting in 9578 kWh.

Figure 4 shows the relationship between heat loss and the integrated heat pump capacity. The balance point occurs at the temperature where the heat loss and steady-state capacity are equal. At lower temperatures, supplemental heat is required, and at higher temperatures the heat pump cycles on and off.

To properly predict the energy use of the heat pump system, actual dynamic performance data, including cycling losses, should be used. For the heat pump system, performance data should include the effects of cycling above the building balance temperature, frosting, defrosting, and the effect of auxiliaries. These losses may be significant, depending on the size of the heat pump compared to the building heat loss and the control methodology of the heat pump.

Table 3 Sample Annual Bin Data

City	100/104	95/99	90/94	85/89	80/84	75/79	70/74	65/69	60/64	55/59	50/54	45/49	40/44	35/39	30/34	25/29	20/24	15/19	10/14	5/9	0/4	−5/1	−10/6	−15/11	−20/16	−25/21
Albuquerque	1	54	191	348	511	617	789	785	816	676	637	720	678	676	560	406	180	101	31	3						
Bismarck		11	68	173	252	320	450	590	625	550	583	506	624	539	626	596	424	399	391	306	364	144	131	43	42	3
Chicago			97	222	362	512	805	667	615	622	585	577	636	720	957	511	354	243	125	66	58	6				
Dallas/Ft. Worth	27	210	351	527	804	1100	947	705	826	761	615	615	523	364	289	57	29									
Denver		3	118	235	348	390	472	697	699	762	783	718	665	758	713	565	399	164	106	65	80	22				
Los Angeles	8	8	9	17	53	194	632	1583	234	2055	1181	394	74	4												
Miami			45	864	1900	2561	1605	871	442	222	105	77	36	12												
Nashville		7	137	407	616	756	1100	866	706	692	650	670	720	582	342	280	107	71	29							
New York City		5	26	170	383	664	820	941	763	699	593	690	765	858	648	377	212	99	20	5						
Seattle				16	62	139	256	450	769	1353	1436	1461	1413	915	358	51	43	15	1							

Table 4 Calculation of Annual Heating Energy Consumption for Example 2

Climate		House		Heat Pump								Supplemental	
A	B	C	D	E	F	G	H	I	J	K	L	M	N
Temp. Bin, °F	Temp. Diff., $t_{bal} - t_{bin}$	Weather Data Bin, h	Heat Loss Rate, 1000 Btu/h	Heat Pump Integrated Heating Capacity, 1000 Btu/h	Cycling Capacity Adjustment Factor[a]	Adjusted Heat Pump Capacity, 1000 Btu/h[b]	Rated Electric Input, kW	Operating Time Fraction[c]	Heat Pump Supplied Heating, 10^6 Btu[d]	Seasonal Heat Pump Electric Consumption, kWh[e]	Space Load, 10^6 Btu[f]	Supplemental Heating Required, kWh[g]	Total Electric Energy Consumption[h]
62	2.3	740	1.8	44.3	0.760	33.7	3.77	0.05	1.30	146	1.30	—	146
57	7.3	673	5.5	41.8	0.783	32.7	3.67	0.17	3.72	417	3.72	—	417
52	12.3	690	9.3	39.3	0.809	31.8	3.56	0.29	6.42	719	6.42	—	719
47	17.3	684	13.1	36.8	0.839	30.9	3.46	0.42	8.95	1002	8.95	—	1002
42	22.3	790	16.9	29.9	0.891	26.6	3.23	0.63	13.31	1614	13.31	—	1614
37	27.3	744	20.6	28.3	0.932	26.4	3.15	0.78	15.35	1833	15.35	—	1833
32	32.3	542	24.4	26.6	0.979	26.0	3.07	0.94	13.22	1559	13.22	—	1559
27	37.3	254	28.2	25.0	1.000	25.0	3.00	1.00	6.35	762	7.16	236	998
22	42.3	138	31.9	23.4	1.000	23.4	2.92	1.00	3.23	403	4.41	345	748
17	47.3	54	35.7	21.8	1.000	21.8	2.84	1.00	1.18	153	1.93	220	373
12	52.3	17	39.5	19.3	1.000	19.3	2.74	1.00	0.33	47	0.67	101	147
7	57.3	2	43.3	16.8	1.000	16.8	2.63	1.00	0.03	5	0.09	16	21
2	62.3	0	47.0	14.3	1.000	—	—	—	—	—	—	—	—
								TOTALS:	73.39	8660	76.52	917	9578

[a]Cycling Capacity Adjustment Factor = $1 - C_d(1 - x)$ when C_d = degradation coefficient, default = 0.25, unless part load factor is known, and x = building heat loss/unit capacity at temperature bin. Cycling capacity = 1 at the balance point and below.
[b]Col. G = Col. E × Col. F
[c]Operating Time Factor equals the smaller of 1 or Col. D/Col. G
[d]Col. J = (Col. I × Col. G × Col. C)/1000
[e]Col. K = Col. I × Col. H × Col. C
[f]Col. L = Col. C × Col. D/1000
[g]Col. M = Col. L − Col. J
[h]Col. N = Col. K + Col. M

I - IMPLEMENTATION DOCUMENTATION

1. COMPONENT ARMY	FY 1996 ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) PROJECT DATA	2. DATE APRIL 1994 95% EEAP

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
FORT SAM HOUSTON, SAN ANTONIO, TEXAS	(ECIP), DINING FACILITIES

5. PROGRAM ELEMENT	6. CATEGORY CODE	7. PROJECT NUMBER	8. PROJECT COST ($000)
	80000		1,188

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
DINING FACILITIES		-	-	
ENERGY RETROFIT	SF	76,110	12.60	958.6
		-	-	
SUBTOTAL	-	-	-	958.6
CONTINGENCY (10%)	-	-	-	106.5
TOTAL CONTRACT COST	-	-	-	1,065.1
SUPERVISION, INSPECTION & OVERHEAD (6.0%) .	-	-	-	58.6
DESIGN COST (6%)	-	-	-	63.9
TOTAL REQUEST	-	-	-	1,187.5
TOTAL REQUEST ROUNDED	-	-	-	4
				1,188

10. DESCRIPTION OF PROPOSED CONSTRUCTION:

The energy retrofit at Fort Sam Houston consists of work related to seventeen (17) Dining Facilities, which contain 76,110 square feet. The retrofit includes retrofit of lighting and HVAC systems. The retrofit systems results in a simple payback of 6.2 years and a Savings to Investment Ratio (SIR) of 2.43. The Adjusted Internal Rate of Return (AIRR) is 8.7%. This retrofit will improve efficiency, reduce maintenance cost and will reduce energy consumption.

COMPOSITE PROJECT SUMMARY

Listed in Table 2A is a compilation of all recommended ECO's. Tables 3A and 3B are compilations of all recommended ECO's studied as well as the analysis results for each ECO. Table 3A is sorted by building number and Table 3B is sorted by descending SIR. Also, shown in Table 2A are the ECO numbers and ECO descriptions analyzed for this report. A detailed summary of each ECO may be found with each building description and analysis.

SUMMARY OF PROJECT

(All recommended ECO's included - see Table 4 for ECIP summary calculations)

KWH Savings:	2,263,894	KWH/yr
Demand Savings:	7,241.9	KW
Gas Savings:	1,648.4	MCF/yr
Cost Savings:	$ 140,319.00	/Year
Implementation Cost:	$ 1,187,540.00	
Simple Payback:	6.2	Years
Savings to Investment: Ratio (SIR)	2.43	

This report identified capital intensive projects which, if implemented, will result in the savings and costs summarized above. The savings for the recommended composite project listed above account for interdependence of savings of individual ECO's.

SPECIAL CONSIDERATIONS

UTILITY REBATES

City Public Service does not currently offer any utility rebate incentives for energy retrofit measures.

MAINTENANCE AND OPERATION OF RETROFITTED SYSTEMS.

The combination of ECO's identified in this report will result in an overall decrease in maintenance labor and cost. This is due primarily to the installation of new lighting systems with increased service lives and a reduction in operating hours for mechanical equipment with the addition of automatic stop/start functions. Addition of automatic stop/start functions will also extend the useful life of the equipment.

TABLE 2A. SUMMARY OF RECOMMENDED ECO'S AND M & O'S

ENERGY CONSERVATION OPPORTUNITIES	ECO/ M & O	BUILDING # 44	48	368	407	1350	1387	1395	1462	1520	1630	2265	2399	2521	2530	2652	2841	5105	5106	5107	5114	5124	GEN
I. ENVELOPE																							
A. ADDITIONAL INSULATION/SEALING	M & O			X																			
B. INSULATED GLASS OR GLAZING																							
C. WEATHER STRIPING AND CAULKING																							
II. HOT WATER																							
A. SHUTDOWN ENERGY TO WATER HEATER																							
B. ADDITION OF BOOSTER HEATERS AT MAJOR HW USERS																							
C. ADDITION OF INSTANTANEOUS WATER HEATERS																							
III. HEAT RECOVERY																							
A. HEAT RECOVERY FROM DISHWASHERS HOT WATER																							
B. HEAT RECLAIM FROM KITCHEN EXHAUST																							
C. WASTE HEAT RECOVERY																							
IV. HVAC																							
A. NIGHT SETBACK/SETUP THERMOSTAT	ECO	X		X									X	X			X						
B. ECONOMIZER CYCLE(DRY BULB) 0																							
C. UPGRADE HVAC CONTROLS																							
1) ADD STOP/START FUNCTION TO HVAC EQUIPMENT	ECO				X											X				X			
D. IMPROVE EFFICIENCY OF OPERATIONS																							
1) REPLACE CHILLER WITH HIGHER EFF/CFC FREE CHILLER	ECO					X		X				X	X										
2) REPLACE RTU WITH HIGHER EFFICIENCY UNIT																							
E. BALANCE HVAC SYSTEM	M & O											X											
F. INSTALL MAKE-UP AIR SUPPLY FOR KITCHEN AREAS	ECO												X										
G. SHUT-OFF RANGE HOOD																							
H. THERMAL STORAGE																							
V. BOILER/STEAM																							
A. STEAM TRAP INSPECTION	M & O												X										
B. INSULATE STEAM AND CONDENSATE LINES																							
VI. POWER																							
A. CONVERT TO ENERGY EFFICIENT/SMALLER MOTORS	M & O																						X
VII. REDUCE/ENHANCE LIGHTING																							
A. PHOTOCELLS FOR LIGHTING																							
B. TIMERS FOR LIGHTING																							
C. REMOVE UNEEDED LAMPS OR FIXTURES	ECO				X							X					X						
D. REDUCE INDOOR/OUTDOOR LIGHTING TO AEI LEVELS	ECO	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X			X			
E. LOWER LIGHT FIXTURES																							
F. IMPROVE REFLECTION WITH LIGHT COLORED CEILINGS/WALLS																							
VIII. IMPROVE LIGHTING CONTROLS																							
A. INSTALL OCCUPANCY SENSORS																							
B. SEPERATE SWITCHES TO CONTROL LIGHTING																							
IX. IMPROVE LIGHTING EFFICIENCY																							
A. REPLACE INCANDESCENT LAMPS WITH COMPACT FLUORESCENTS	ECO		X	X	X		X	X		X	X		X	X		X	X			X			
B. REPLACE INCANDESCENT EXIT FIXTURES WITH LED	ECO				X				X	X		X	X		X	X	X			X			
C. REPLACE STANDARD LAMPS WITH ENERGY SAVING LAMPS	ECO	X		X	X	X	X	X	X	X		X	X		X	X	X			X			
D. REPLACE STANDARD BALLAST WITH ENERGY SAVING BALLAST	ECO	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X			X			
E. REPLACE EXISTING FIXTURES WITH HIGH EFF. FIXTURES	ECO																X						
X. REFRIGERATION EQUIPMENT																							
A. IMPROVE EFFICIENCY OF REFIGERATION EQUIPMENT																							
B. ADD PLASTIC AIR CURTAINS TO PREVENT INFILTRATION	M & O			X	X		X	X					X				X			X			
XI. OTHER																							
A. REPLACE BOILERS WITH 99% EFFICIENT BOILER																							
B. REDUCE HW TEMPERATURE TO 140 ^F	M & O			X																			
C. RESTORE OPEARTION OF VENTILATION UNIT	M & O																			X			

TABLE 3A. COMPOSITE ECO SUMMARY (BY BUILDING)

BUILDING NUMBER	ECO NUMBER	USAGE SAVINGS (KWH/YR)	DEMAND SAVINGS (KW/YR)	GAS SAVINGS (MCF/YR)	MAINT. SAVINGS ($/YR)	COST SAVINGS ($/YR)	IMPLEMENTATION COST ($)	SIMPLE PAYBACK (YEARS)	SAVING TO INV. RATIO (SIR)
BUILDING 44	IV.A	472	0	3.5	−$5.00	$29.00	$122.00	5.1	2.7
BUILDING 44	VII.C,D & IX C, D	8,409	18.6	N/A	$33.00	$460.00	$2,117.00	4.6	2.28
BUILDING 48	IX.A	709	2.6	N/A		$54.00	$89.00	1.7	5.41
BUILDING 368	IV.A	2,649	0.0	19.6	−$15.00	$164.00	$363.00	2.4	5.5
BUILDING 368	VII.C,D & IX A, C, D	19,807	43.9	N/A	$110.00	$1,116.00	$2,244.00	2	5.07
BUILDING 407	IV.C.1	181,265	0.0	660.6	−$45.00	$8,781.00	$2,233.00	0.3	34.9
BUILDING 407	VII.C, D & IX A, B, C, D	12,315	53.2	N/A	$214.00	$1,012.00	$4,557.00	4.5	1.97
BUILDING 1350	IV.D.1)	126,750	528.0	0.0		$8,084.00	$231,987.00	11.8	1.05
BUILDING 1350	VII.C,D, & IX B,C,D.	23,724	67.0	N/A	$289.00	$2,783.00	$9,130.00	3.3	3.45
BUILDING 1387	VII C,D, & IX.A,B,C,D	19,311	29.9	N/A	$127.00	$1,022.00	$2,592.00	2.5	4.46
BUILDING 1395	IV.D. 1)	123,020	1,152.0	N/A		$12,302.00	$159,262.00	8.2	1.81
BUILDING 1395	VII.C,D & IX.A,B,C,D	42,637	53.7	N/A	$286.00	$2,179.00	$4,850.00	2.2	5.08
BUILDING 1462	VII.C,D & IX.B,C,D	8,760	15.4	N/A	$37.00	$455.00	$1,037.00	2.3	4.96
BUILDING 1520	VII C, D, & IX.A,B,C,D	12,030	26.8	N/A	$52.00	$664.00	$2,447.00	3.7	3.06
BUILDING 1630	VII.C,D & IX.A,C,D	2,397	5.5	N/A	$10.00	$133.00	$357.00	2.7	4.21
BUILDING 2265	IV.D 1)	424,595	1,740.0	N/A		$26,888.00	$338,516.00	7.7	2.02
BUILDING 2265	VII.C,D, & IX B,C,D	49,856	46.7	N/A	$242.00	$2,349.00	$2,723.00	1.2	9.77
BUILDING 2399	IV.A	7,528	0.0	89.1	−$15.00	$575.00	$363.00	0.6	21.15
BUILDING 2399	IV. D. 1)	926,098	3,192.0	N/A		$54,626.00	$365,824.00	5.1	3.02
BUILDING 2399	IV. F. 1.	41,614	0.0	617.0		$3,604.00	$31,268.00	8.7	2.09
BUILDING 2399	IV. F. 2.	4,776	0.0	70.8		$414.00	$3,976.00	9.6	1.89
BUILDING 2399	VII.C,D & IX.A,B,C,D	18,019	28.4	N/A	$269.00	$1,574.00	$8,895.00	5.7	2
BUILDING 2521	IV A.	278	0.0	2.1	−$5.00	$17.00	$122.00	10	1.42
BUILDING 2521	VII.C,D & IX.A,C,D	2,994	13.3	N/A	$15.00	$212.00	$866.00	4.1	2.75
BUILDING 2530	VII, C,D & IX.B,C,D	5,444	9.1	N/A	$23.00	$280.00	$591.00	2.1	5.36
BUILDING 2652	IV.C. 1)	41,114	0.0	39.0		$1,613.00	$2,292.00	1.4	8.49
BUILDING 2652	VIII.C,D & IX,A,B,C,D	8,090	11.7	N/A	$36.00	$406.00	$1,588.00	3.9	2.89
BUILDING 2841	IV.A	2,000	0.0	23.5	−$10.00	$152.00	$242.00	1.7	8.13
BUILDING 2841	VII.C,D, & IX.A,B,C,D,E	111,658	185.9	N/A	$1,703.00	$6,903.00	$4,343.00	0.6	18.1
BUILDING 5105	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BUILDING 5107	IV.C. 1)	22,613	0.0	N/A	−$15.00	$814.00	$425.00	0.5	22.17
BUILDING 5107	VII.C,D, & IX.A,B,C,D	12,962	18.2	N/A	$66.00	$654.00	$2,119.00	3.2	3.49
BUILDING 5114	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BUILDING 5124	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL		2,263,894	7,241.9	1,525.2	$3,402.00	$140,319.00	$1,187,540.00	6.20	2.43

TABLE 3B. COMPOSITE ECO SUMMARY (BY SIR)

BUILDING NUMBER	ECO NUMBER	USAGE SAVINGS (KWH/YR)	DEMAND SAVINGS (KW/YR)	GAS SAVINGS (MCF/YR)	MAINT. SAVINGS ($/YR)	COST SAVINGS ($/YR)	IMPLEMENTATION COST ($)	SIMPLE PAYBACK (YEARS)	SAVING TO INV. RATIO (SIR)
BUILDING 407	IV.C.1	181,265	0.0	660.6	-$45.00	$8,781.00	$2,233.00	0.3	34.9
BUILDING 5107	IV.C. 1)	22,613	0.0	N/A	-$15.00	$814.00	$425.00	0.5	22.17
BUILDING 2399	IV.A	7,528	0.0	89.1	-$15.00	$575.00	$363.00	0.6	21.15
BUILDING 2841	VII.C,D, & IX.A,B,C,D,E	111,658	185.9	N/A	$1,703.00	$6,903.00	$4,343.00	0.6	18.1
BUILDING 2265	VII.C,D, & IX B,C,D	49,856	46.7	N/A	$242.00	$2,349.00	$2,723.00	1.2	9.77
BUILDING 2652	IV.C. 1)	41,114	0.0	39.0		$1,613.00	$2,292.00	1.4	8.49
BUILDING 2841	IV.A	2,000	0.0	23.5	-$10.00	$152.00	$242.00	1.7	8.13
BUILDING 368	IV.A	2,649	0.0	19.6	-$15.00	$164.00	$363.00	2.4	5.5
BUILDING 48	IX.A	709	2.6	N/A		$54.00	$89.00	1.7	5.41
BUILDING 2530	VII, C,D & IX.B,C,D	5,444	9.1	N/A	$23.00	$280.00	$591.00	2.1	5.36
BUILDING 1395	VII.C,D & IX.A,B,C,D	42,637	53.7	N/A	$286.00	$2,179.00	$4,850.00	2.2	5.08
BUILDING 368	VII.C,D & IX A, C, D	19,807	43.9	N/A	$110.00	$1,116.00	$2,244.00	2	5.07
BUILDING 1462	VII.C,D & IX.B,C,D	8,760	15.4	N/A	$37.00	$455.00	$1,037.00	2.3	4.96
BUILDING 1387	VII C,D, & IX.A,B,C,D	19,311	29.9	N/A	$127.00	$1,022.00	$2,592.00	2.5	4.46
BUILDING 1630	VII.C,D & IX.A,C,D	2,397	5.5	N/A	$10.00	$133.00	$357.00	2.7	4.21
BUILDING 5107	VII.C,D, & IX.A,B,C,D	12,962	18.2	N/A	$66.00	$654.00	$2,119.00	3.2	3.49
BUILDING 1350	VII.C,D, & IX B,C,D.	23,724	67.0	N/A	$289.00	$2,783.00	$9,130.00	3.3	3.45
BUILDING 1520	VII C, D, & IX.A,B,C,D	12,030	26.8	N/A	$52.00	$664.00	$2,447.00	3.7	3.06
BUILDING 2399	IV. D. 1)	926,098	3,192.0	N/A		$54,626.00	$365,824.00	5.1	3.02
BUILDING 2652	VIII.C,D & IX,A,B,C,D	8,090	11.7	N/A	$36.00	$406.00	$1,588.00	3.9	2.89
BUILDING 2521	VII.C,D & IX.A,C,D	2,994	13.3	N/A	$15.00	$212.00	$866.00	4.1	2.75
BUILDING 44	IV.A	472	0	3.5	-$5.00	$29.00	$122.00	5.1	2.7
BUILDING 44	VII.C,D & IX C, D	8,409	18.6	N/A	$33.00	$460.00	$2,117.00	4.6	2.28
BUILDING 2399	IV. F. 1.	41,614	0.0	617.0		$3,604.00	$31,268.00	8.7	2.09
BUILDING 2265	IV.D 1)	424,595	1,740.0	N/A		$26,888.00	$338,516.00	7.7	2.02
BUILDING 2399	VII.C,D & IX.A,B,C,D	18,019	28.4	N/A	$269.00	$1,574.00	$8,895.00	5.7	2
BUILDING 407	VII.C, D & IX A, B, C, D	12,315	53.2	N/A	$214.00	$1,012.00	$4,557.00	4.5	1.97
BUILDING 2399	IV. F. 2.	4,776	0.0	70.8		$414.00	$3,976.00	9.6	1.89
BUILDING 1395	IV.D. 1)	123,020	1,152.0	N/A		$12,302.00	$159,262.00	8.2	1.81
BUILDING 2521	IV A.	278	0.0	2.1	-$5.00	$17.00	$122.00	10	1.42
BUILDING 1350	IV.D.1)	126,750	528.0	0.0		$8,084.00	$231,987.00	11.8	1.05
BUILDING 5114	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BUILDING 5105	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BUILDING 5124	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL		2,263,894	7,241.9	1,525.2	$3,402.00	$140,319.00	$1,187,540.00	6.20	2.43

TABLE 4. ECIP SUMMARY

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: COMPOSITE ECO SUMMARY
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 20 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$1,065,058		
B. SIOH	$58,578		
C. DESIGN COST	$63,903		
D. TOTAL COST (1A+1B+1C)	$1,187,540		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D−1E−1F)			$1,187,540

2. ENERGY SAVINGS (+)/COST(−):

DATE OF NISTIR 85−3273−X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	7726.67	$81,516	14.65	$1,194,215
B. DIST			$0	17.70	$0
C. RESID			$0	20.99	$0
D. NG	$3.31	1699.50	$5,625	20.60	$115,882
E. PPG			$0	13.59	$0
F. COAL			$0	16.32	$0
G. SOLAR			$0	13.59	$0
H. GEOTH			$0	13.59	$0
I. BIOMA			$0	13.59	$0
J. REFUS			$0	13.59	$0
K. WIND			$0	13.59	$0
L. OTHER			$0	13.59	$0
M. DEMAND SAVINGS			$48,279	13.59	$656,109
N. TOTAL		9426.17	$135,421		$1,966,206

3. NON ENERGY SAVINGS (+) OR COST (−):

A. ANNUAL RECURRING (+/−)	$3,402		
1. DISCOUNT FACTOR (TABLE A)		13.59	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$46,233

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV-INGS(+)COST(−)(4)
a.	N/A	$429,288	1	0.96	$412,116
b.	N/A	$0	2	0.92	$0
c.	N/A	$338,516	3	0.89	$301,279
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$51,000	13	0.6	$30,600
n.	N/A	$0	14	0.58	$0
o.	Chiller	$231,987	15	0.56	$129,913
p.	TOTAL	$1,050,791			$873,908

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $920,142

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 6.2 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $2,886,347

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 2.43

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 8.7%

CONCLUSIONS

The results of this analysis indicate that the ECO's recommended result in a project which is eligible of ECIP funding. The approximate implementation cost for the project is $1,187,540.00 with a simple payback of 6.2 years and an SIR of 2.43. The adjusted internal rate of return is 8.7%.

MAINTENANCE AND OPERATIONAL RECOMMENDATIONS

I. ENVELOPE

A. Additional Insulation/Sealing

The ductwork for the rooftop unit serving the office area in Building 368 should be resealed.

IV. HVAC

E. Balance HVAC System

The make-up air kitchen hoods for Building 2265 have the make-up supply louvers closed. These supply louvers should be fully open in order for the hood to function properly.

V. BOILER/STEAM

A. Steam Trap Inspection

The steam traps for Building 2399 appear to be original to the building and should be replaced to prevent blow by of live steam.

X. REFRIGERATION EQUIPMENT

B. Add Plastic Air Curtains to Prevent Infiltration

The following buildings have walk-in freezers and refrigerators that do not have plastic air curtains or have torn curtains in need of replacement; Buildings 368, 407, 1387, 1395, 2399, 2841 and 5107. Addition or replacement of air curtains will reduce energy consumption due to infiltration and exfiltration.

XI. OTHER

B. Reduce Hot Water Temperature to 140°F

Currently, the domestic hot water temperature is set at 160°F for Building 368. This facility contains an automatic dishwasher with a booster heater for sanitization. The optimum temperature for the domestic hot water is 140°F. Reducing the temperature will result in a reduction in energy consumption.

C. Restore Operation of Ventilation Unit

Currently, a ventilation unit is disabled which is intended to serve the kitchen area for Building 5107. As a result, the kitchen hoods are exhausting conditioned air from the adjacent dining area. Restoring operation of this unit would reduce energy consumption related to the exhausted conditioned air.

ENERGY CONSERVATION ANALYSIS

BUILDING 44 - SNACK BAR

Building 44 is primarily a one story building with a total of 95,000 square feet. The snack bar is contained within this facility and consists of approximately 2,000 square feet.

The operating hours are from 6:00 am to 2:00 pm, 5 days per week.

The lighting system is primarily fluorescent.

The mechanical system consists of a 3 ton packaged DX rooftop unit with gas heating and a kitchen exhaust hood.

Hot water is supplied by the central building, gas fired, domestic hot water boiler. There is no dishwashing equipment and all dishes and utensils are disposable.

The following ECO's are recommended for Building 44:

1. IV. A - Night setback/setup thermostat
2. VII. D - Reduce indoor/outdoor lighting to AEI levels
3. IX. C - Replace standard lamps with energy saving lamps
4. IX. D - Replace standard ballast with energy saving ballast

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 44

ECO NO: IV.A.

ECO NAME: Night setback/setup thermostat.

SUMMARY DATA (DEPENDENT):

KWH Savings:	472	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	3.5	MCF/yr
Cost Savings:	$ 29.00	/yr
Implementation Cost:	$ 122.00	
Simple Payback:	4.2	Years
Savings to Investment: Ratio (SIR):	3.15	

ECO DESCRIPTION:

Currently, a manual thermostat is used to control the packaged DX rooftop unit which serves the snack bar. This ECO analyzes the installation of a programmable night setback/setup thermostat to reduce energy consumption during unoccupied periods.

COST SAVINGS CALCULATIONS:

(Refer to following SimpCalc Calculations)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

MAINTENANCE COSTS:

Maintenance costs of $5.00/year is included in the LCCA for programming, battery replacement and failures.

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 0044 – ECO IV. A. – NIGHT SETBACK/SETUP THERMOSTAT
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$109		
B. SIOH	$6		
C. DESIGN COST	$7		
D. TOTAL COST (1A+1B+1C)	$122		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$122

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	1.61	$17	11.77	$200
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	3.61	$12	15.34	$183
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. OTHER			$0	11.12	$0
M. DEMAND SAVINGS			$0	11.12	$0
N. TOTAL		5.22	$29		$383

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	–$5		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			–$56

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV− INGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) −$56

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 5.1 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $328

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 2.70

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 11.1%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 44

ECO NO: VII. D. & IX C.,D.

ECO NAME: Improve lighting efficiency

SUMMARY DATA (DEPENDENT):

KWH Savings:	8,409	KWH/yr
Demand Savings:	18.6	KW/yr
Gas Savings:	N/A	MCF/yr
Cost Savings:	$ 460.00	/yr
Implementation Cost:	$ 2,117.00	
Simple Payback:	4.6	Years
Savings to Investment: Ratio (SIR):	2.28	

ECO DESCRIPTION:

Currently, low efficiency lighting systems are in use. This ECO will update the lighting system to improve efficiency while maintaining or increasing lighting levels. The existing lighting system and proposed retrofit action are as follows:

QTY	FIXTURE TYPE	ACTION
12	2-Lamp, 4' Fluor.	Retrofit w/T8 lamps and electronic ballasts.
8	4-Lamp, 4' Fluor.	Retrofit w/T8 lamps and electronic ballasts.
20	2-Lamp, 8' Fluor.	Retrofit w/T8 lamps and electronic ballasts.

COST SAVINGS CALCULATIONS:

(Refer to following Flex Output)

$$Demand\ Savings = [(4.49KW - 2.94KW) \times 4mo. x \$7.50/KW + (4.49KW - 2.94KW) x 8 mo. x \$6.25/KW]$$
$$= \$124.00/yr$$

IMPLEMENTATION COSTS:

(Refer to following Flex Output and Lighting Implementation Cost located in Appendix E)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 0044 – ECO VII. D. & IX C., D. – LIGHTING IMPROVEMENTS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$1,899		
B. SIOH	$104		
C. DESIGN COST	$114		
D. TOTAL COST (1A+1B+1C)	$2,117		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$2,117

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	11.91	$126	11.77	$1,479
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG			$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. COOLING	$10.55	16.79	$177	11.12	$1,970
M. DEMAND SAVINGS			$124	11.12	$1,379
N. TOTAL		28.7	$427		$4,828

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$33		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$366

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(–)

	ITEM	SAVINGS(+) COST(–)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV–INGS(+)COST(–)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $366

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 4.6 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $5,194

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 2.45

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 10.4%

ENERGY CONSERVATION ANALYSIS

BUILDING 48 - VIP GUEST HOUSE DINING

Building 48 is a historic two story, wood frame building with a total of 8,600 square feet. The dining and kitchen facilities are located on the first floor and consist of approximately 500 square feet.

The operating hours are from 5:30 am to 11:00 am, 5 days per week.

The lighting system is primarily incandescent with chandeliers in the dining room and recessed incandescent fixtures in the kitchen.

The mechanical system consists of a wall mounted fan coil unit which is provided with chilled water by an air cooled chiller. Heating is provided by a gas fired boiler located in the basement.

Hot water is supplied by a gas fired water heater located in the basement. All dishes are washed by hand.

The following ECO's are recommended for Building 48:

1. IV. A - Night setback/setup thermostat
2. IX. A - Replace incandescent lamps with compact fluorescents

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 48

ECO NO: IX.A.

ECO NAME: Replace incandescent lamps with compact fluorescents

SUMMARY DATA (DEPENDENT):

KWH Savings:	709	KWH/yr
Demand Savings:	2.59	KW/yr
Gas Savings:	N/A	MCF/yr
Cost Savings:	$ 54.00	/yr
Implementation Cost:	$ 89.00	
Simple Payback:	1.7	Years
Savings to Investment: Ratio (SIR):	5.41	

ECO DESCRIPTION:

Currently, recessed incandescent fixtures are utilized in the kitchen area. This ECO replaces the incandescent lamps with 27W compact fluorescent lamps. The existing lighting system and proposed retrofit action are as follows:

QTY	FIXTURE TYPE	ACTION
1	Fan/Chandelier	None.
3	Incandescent downlight	Replace with compact fluor.

COST SAVINGS CALCULATIONS:

(Refer to following Flex Output)

Demand Savings = (.34 *KW* − 1.24 *KW*) x 4 *mo.* x $7.50/*KW* + (.34 *KW* − .124 *KW*) x 8 *mo.* x $6.25/*KW*
= $17.28/*yr*

IMPLEMENTATION COSTS:

(Refer to following Flex Output and Lighting Implementation Cost located in Appendix E)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BLDG 0048 – ECO IX A. – REPLACE INCANDESCENT LAMPS W/COMPACT FLUOR.
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$80		
B. SIOH	$4		
C. DESIGN COST	$5		
D. TOTAL COST (1A+1B+1C)	$89		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$89

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	1.01	$11	11.77	$125
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG			$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. COOLING	$10.55	1.41	$15	11.12	$165
M. DEMAND SAVINGS			$17	11.12	$192
N. TOTAL		2.42	$43		$483

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$11		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$122

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(–)

	ITEM	SAVINGS(+) COST(–)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAVINGS(+)COST(–)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $122

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 1.7 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $605

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 6.78

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 18.2%

ENERGY CONSERVATION ANALYSIS

BUILDING 368 - CAFETERIA

Building 368 is a one story stucco building consisting of 5,700 square feet. This facility consists of full service kitchen and a large dining area.

The operating hours are from 6:00 am to 2:0 pm, 5 days per week.

The lighting system is primarily fluorescent with some decorative incandescent fixtures.

The mechanical system consists of 3 DX packaged rooftop units. Heating is provided by gas furnaces in the rooftop units.

Hot water is provided by a gas fired water heater. Dishwashing is accomplished using an automatic dishwasher with an electric hot water booster heater.

The following ECO's are recommended for Building 368:

1. IV. A - Night setback/setup thermostat
2. VII. D - Reduce indoor/outdoor lighting to AEI levels
3. IX. A - Replace incandescent lamps with compact fluorescents
4. IX. C - Replace standard lamps with energy saving lamps
5. IX. D - Replace standard ballast with energy saving ballast

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING 368

ECO NO: IV.A.

ECO NAME: Night setback/setup thermostat

SUMMARY DATA (DEPENDENT):

KWH Savings:	2,649	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	19.6	MCF/yr
Cost Savings:	$ 164	/yr
Implementation Cost:	$ 363.00	
Simple Payback:	2.2	Years
Savings to Investment: Ratio (SIR):	5.96	

ECO DESCRIPTION:

Currently, three manual thermostats are used to control the three packaged rooftop units that serve the cafeteria and office areas. This ECO analyzes the installation of programmable night setback/setup thermostats to reduce energy consumption during unoccupied periods.

COST SAVINGS CALCULATIONS:

(Refer to following SimpCalc Calculations)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

MAINTENANCE COSTS:

Maintenance costs of $5.00/year is included in the LCCA for programming, battery replacement and failures.

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 0368 – ECO IV. A. – NIGHT SETBACK/SETUP THERMOSTAT
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$326		
B. SIOH	$18		
C. DESIGN COST	$20		
D. TOTAL COST (1A+1B+1C)	$363		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$363

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	9.19	$97	11.77	$1,141
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	20.21	$67	15.34	$1,026
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. OTHER			$0	11.12	$0
M. DEMAND SAVINGS			$0	11.12	$0
N. TOTAL		29.4	$164		$2,167

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	($15)		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			($167)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(–)

	ITEM	SAVINGS(+) COST(–)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV–INGS(+)COST(–)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) ($167)

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 2.4 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $2,001

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 5.50

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 16.5%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 368

ECO NO: VII. D & IX A, C, D

ECO NAME: Improve lighting efficiency.

SUMMARY DATA (DEPENDENT):

KWH Savings:	19,807	KWH/yr
Demand Savings:	43.9	KW/yr
Gas Savings:	N/A	MCF/yr
Cost Savings:	$ 1,116	/yr
Implementation Cost:	$ 2,244	
Simple Payback:	2.0	Years
Savings to Investment: Ratio (SIR):	5.07	

ECO DESCRIPTION:

Currently, low efficiency lighting systems are in use. This ECO will update the lighting systems to improve efficiency while maintaining or increasing current lighting levels. The existing lighting system and proposed retrofit action are as follows:

QTY	FIXTURE TYPE	ACTION
21	Decorative incandescents	Retrofit with compact fluor. lamps.
11	2-Lamp, 2' Fluor.	Retrofit with T8 lamps and elect. ballasts.
32	2-Lamp, 4' Fluor.	Retrofit with T8 lamps and elect. ballasts.

COST SAVINGS CALCULATIONS:

(Refer to following Flex Output)

$$KWH\ Demand\ Savings = [(7.41KW - 3.75KW) x 4 mo. x \$7.50/KW + (7.41KW - 3.75KW) x 8 mo. x \$6.25/KW]$$
$$= \$292.80/yr$$

IMPLEMENTATION COSTS:

(Refer to following Flex Output and Lighting Implementation Cost located in Appendix E)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 0368 – ECO VII. D. & IX C., D. – LIGHTING IMPROVEMENTS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$2,013		
B. SIOH	$111		
C. DESIGN COST	$121		
D. TOTAL COST (1A+1B+1C)	$2,244		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$2,244

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	28.13	$297	11.77	$3,493
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG			$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. COOLING	$10.55	39.47	$416	11.12	$4,630
M. DEMAND SAVINGS			$293	11.12	$3,256
N. TOTAL		67.6	$1,006		$11,379

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$110		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$1,221

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(–)

	ITEM	SAVINGS(+) COST(–)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV–INGS(+)COST(–)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $1,221

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 2.0 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $12,600

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 5.61

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 16.7%

ENERGY CONSERVATION ANALYSIS

BUILDING 407 - OFFICERS CLUB DINING

Building 407 is a two story stucco building consisting of 41,000 square feet. This facility contains a full service kitchen and a large dining area which consists of 7,800 square feet.

The operating hours are from 6:00 am to 10:00 pm Wednesday thru Saturday and 6:00 am to 3:00 pm Sunday thru Tuesday.

The lighting system is a combination of incandescent and fluorescent fixtures. The dining areas use incandescent downlights and chandeliers. The kitchen uses fluorescent fixtures.

The mechanical system consists of a rooftop multizone air handling unit for the main dining and kitchen areas served by an air cooled chiller. The auxiliary dining rooms and the remainder of the building are served by Direct Expansion (DX) fan coil units with water cooled reciprocating compressors.

Hot water is provided to the kitchen via a steam to hot water converter located in the basement. Steam is provided by a gas fire boiler. Dishwashing is accomplished using an automatic dishwasher with an electric hot water booster heater.

The following ECO's are recommended for Building 407:

1.	IV. C. 1) -	Add stop//start function to HVAC equipment
2.	VII. C -	Remove unneeded lamps or fixtures
3.	VII. D -	Remove unneeded indoor/outdoor lighting to AEI levels
4	IX. A -	Replace incandescent lamps with compact fluorescents
5.	IX. B -	Replace incandescent exit fixtures with LED
6.	IX. C -	Replace standard lamps with energy savings lamps
3.	IX. D -	Replace standard ballast with energy saving ballast

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's)- BUILDING NO. 407

ECO NO: IV.C.1

ECO NAME: Add stop/start function for HVAC systems.

SUMMARY DATA (DEPENDENT):

KWH Savings:	181,265	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	660.6	MCF/yr
Cost Savings:	$ 8,761	/yr
Implementation Cost:	$ 2,233	
Simple Payback:	.3	Years
Savings to Investment: Ratio (SIR):	49.88	

ECO DESCRIPTION:

Presently, the mechanical systems are not controlled by the existing basewide EMCS system. This ECO analyzes the addition of time clocks and relays to shut-down the HVAC systems during unoccupied hours.

COST SAVINGS CALCULATIONS:

(Refer to following Trace Output)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

MAINTENANCE COSTS:

Maintenance costs of $15/year for each timeclock included in the LCCA for adjustments and failures.

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 0407 – ECO IV. C. 1) – ADD STOP/START FUNCTION TO HVAC EQUIPMENT
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$2,003		
B. SIOH	$110		
C. DESIGN COST	$120		
D. TOTAL COST (1A+1B+1C)	$2,233		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$2,233

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	618.66	$6,527	11.77	$76,821
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	681.08	$2,254	15.34	$34,582
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. OTHER			$0	11.12	$0
M. DEMAND SAVINGS			$0	11.12	$0
N. TOTAL		1299.74	$8,781		$111,403

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	($45)		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			($500)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV−INGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) ($500)

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 0.3 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $110,904

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 49.66

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 34.9%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 407

ECO NO: VII. C, D & IX A, B, C, D

ECO NAME: Improve lighting efficiency.

SUMMARY DATA (DEPENDENT):

KWH Savings:	12,315	KWH/yr
Demand Savings:	53.2	KW/yr
Gas Savings:	N/A	MCF/yr
Cost Savings:	$ 1,012	/yr
Implementation Cost:	$ 4,557.00	
Simple Payback:	4.5	Years
Savings to Investment: Ratio (SIR):	1.97	

ECO DESCRIPTION:

Currently, low efficiency lighting systems are in use. This ECO will update the lighting systems to improve efficiency while maintaining or increasing the current lighting levels. The existing lighting system and proposed retrofit action are as follows:

QTY	FIXTURE TYPE	ACTION
15	Decorative chandelier	None.
16	Decorative wall sconce	None.
26	Incandescent downlights	Retrofit with compact fluor. lamps.
90	2-Lamp, 4' Fluor.	Remove 5 fixtures and retrofit remaining with T8 lamps and electronic ballasts.
3	Incand. Exit Light	Replace with LED exit fixture.

COST SAVINGS CALCULATIONS:

(Refer to following Flex Output)

$$Demand\ Savings = (15.64\ KW - 11.21\ KW) x 4\ mo. x \$7.50/KW + (15.64\ KW - 11.21\ KW) x 8 mo. x \$6.25/KW$$
$$= \$354.40/yr$$

IMPLEMENTATION COSTS:

(Refer to following Flex Output and Lighting Implementation Cost located in Appendix E)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 0407 – ECO VII. C.,D. & IX A., B.,C., D. – LIGHTING IMPROVEMENTS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$4,087		
B. SIOH	$225		
C. DESIGN COST	$245		
D. TOTAL COST (1A+1B+1C)	$4,557		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$4,557

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	17.25	$182	11.77	$2,142
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG			$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. COOLING	$10.55	24.78	$261	11.12	$2,907
M. DEMAND SAVINGS			$354	11.12	$3,941
N. TOTAL		42.03	$798		$8,990

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$214		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$2,375

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAVINGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $2,375

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 4.5 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $11,365

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 2.49

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 10.5%

ENERGY CONSERVATION ANALYSIS

BUILDING 1350 - ACADEMY DINING

Building 1350 is a three story building consisting of approximately 180,000 square feet. This facility contains a full service kitchen and a large dining area which consists of 8,430 square feet.

The operating hours are from 4:30 am to 9:00 pm, 5 days per week.

The lighting system is primarily fluorescent.

The mechanical system consists of multizone air handling units served by a water cooled centrifugal chiller. Heating is provided to the units by two gas fire boilers. The chiller and boilers are located in a remote central mechanical room.

Hot water for the kitchen is provided by two gas fired boilers located in a nearby mechanical room. Dishwashing is accomplished by utilizing an automatic dishwasher with an electric hot water booster heater.

The following ECO's are recommended for Building 1350:

1. IV. D. 1) - Replace chiller with higher EF/CFC free chiller
2. VII. D - Reduce indoor/outdoor lighting to AEI levels
3. IX. C - Replace standard lamps with energy saving lamps
4. IX. D - Replace standard ballast with energy saving ballast

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING 1350

ECO NO: IV.D.1)

ECO NAME: Replace chiller with higher efficiency, CFC free chiller.

SUMMARY DATA (DEPENDENT):

KWH Savings:	126,750	KWH/yr
Demand Savings:	528	KW/yr
Gas Savings:	0	MCF/yr
Cost Savings:	$ 8,084	/yr
Implementation Cost:	$ 231,987.00	
Simple Payback:	11.8	Years
Savings to Investment: Ratio (SIR):	1.05	

ECO DESCRIPTION:

Currently, a 438 ton centrifugal chiller is utilized for Building 1350. This chiller was installed in 1986 and operates at an efficiency of .715 KW/ton. Also, this chiller contains refrigerant R-11. This ECO analyzes replacement of the existing chiller with a CFC free chiller with an operating efficiency of .534 KW/ton. This ECO accounts for the interdependencies related to the operating controls and the proposed lighting retrofit.

COST SAVINGS CALCULATIONS:

(Refer to following Trace Output)

$$KWH\ Savings = (2{,}940{,}848\,KWH/yr - 2{,}814{,}098\,KWH) x \$.036/KWH = \$4{,}563/yr$$

$$Demand\ Savings = (569 - 525\,KW) x 4\,mo. x \$7.50/KW + (569\,KW - 525\,KW) x 8\,mo. x \$6.25/KW$$

$$= \$3{,}520/yr$$

$$Total\ Savings = \$8{,}084/yr$$

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 1350 – ECO IV. D. 1) – REPLACE CHILLER W/ HIGHER EFF/CFC FREE CHILLEF
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 20 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$208,060		
B. SIOH	$11,443		
C. DESIGN COST	$12,484		
D. TOTAL COST (1A+1B+1C)	$231,987		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$231,987

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	432.6	$4,564	14.65	$66,862
B. DIST			$0	17.70	$0
C. RESID			$0	20.99	$0
D. NG	$3.31	0.00	$0	20.60	$0
E. PPG			$0	13.59	$0
F. COAL			$0	16.32	$0
G. SOLAR			$0	13.59	$0
H. GEOTH			$0	13.59	$0
I. BIOMA			$0	13.59	$0
J. REFUS			$0	13.59	$0
K. WIND			$0	13.59	$0
L. OTHER			$0	13.59	$0
M. DEMAND SAVINGS			$3,520	13.59	$47,837
N. TOTAL		432.6	$8,084		$114,698

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$0		
1. DISCOUNT FACTOR (TABLE A)			
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$0

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(–)

	ITEM	SAVINGS(+) COST(–)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV–INGS(+)COST(–)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	Chiller	$231,987	15	0.56	$129,913
p.	TOTAL	$231,987			$129,913

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $129,913

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 11.8 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $244,611

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 1.05

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 4.3%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 1350

ECO NO: VII D. & IX C. D.

ECO NAME: Improve lighting efficiency.

SUMMARY DATA (DEPENDENT):

KWH Savings:	23,724	KWH/yr
Demand Savings:	66.98	KW/yr
Gas Savings:	n/a	MCF/yr
Cost Savings:	$ 2,783	/yr
Implementation Cost:	$ 9,130	
Simple Payback:	3.3	Years
Savings to Investment: Ratio (SIR):	3.45	

ECO DESCRIPTION:

Currently, low efficiency lighting systems are in use. This ECO will update the lighting system to improve efficiency while maintaining or increasing lighting levels. The existing lighting system and proposed retrofit action are as follows:

QTY	FIXTURE TYPE	ACTION
191	1-Lamp, 4' Fluor.	Retrofit with T8 lamps and elect. ballasts.
4	2-Lamp, 4' Fluor.	Retrofit with T8 lamps and elect. ballasts.
24	4-Lamp, 4' Fluor.	Retrofit with T8 lamps and elect. ballasts.

COST SAVINGS CALCULATIONS:

(Refer to following Flex Output)

$$Demand\ Savings = 66.98\,KW x(\frac{4}{12}) x \$7.50/KW + 66.98\,KW x(\frac{8}{12}) x \$6.25/KW$$
$$= \$446.53/yr$$

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate and Lighting Implementation Cost located in Appendix E)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 1350 – ECO VII D. & IX C., D. – LIGHTING IMPROVEMENTS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$8,188		
B. SIOH	$450		
C. DESIGN COST	$491		
D. TOTAL COST (1A+1B+1C)	$9,130		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$9,130

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	80.97	$854	11.77	$10,054
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	0.00	$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. COOLING	$10.55	113.1	$1,193	11.12	$13,268
M. DEMAND SAVINGS			$447	11.12	$4,965
N. TOTAL		194.07	$2,494		$28,288

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$289		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$3,208

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(–)

	ITEM	SAVINGS(+) COST(–)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV–INGS(+)COST(–)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $3,208

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 3.3 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $31,496

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 3.45

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 13.0%

ENERGY CONSERVATION ANALYSIS

BUILDING 1387 - MINI-MALL

Building 1387 is a one story brick facility consisting of several retail shops. This facility contains a small kitchen and dining area which consists of 3,700 square feet.

The operating hours for this facility are from 10:00 am to 9:00 pm, seven days per week.

The lighting system is primarily fluorescent.

The mechanical system consists of DX split systems with gas heating.

Hot water is provided to the kitchen by a gas fired heater. Dishwashing is done by hand using a rinse sink with an electric hot water booster heater.

The following ECO's are recommended for Building 1387:

1. VII. D - Reduce indoor/outdoor lighting to AEI levels
2. IX. A - Replace incandescent lamps with compact fluorescents
3. IX. C - Replace standard lamps with energy saving lamps
4. IX. D - Replace standard ballast with energy saving ballast

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 1387

ECO NO: VII D. & IX A. C. D.

ECO NAME: Improve lighting efficiency.

SUMMARY DATA (DEPENDENT):

KWH Savings:	19,311	KWH/yr
Demand Savings:	29.9	KW/yr
Gas Savings:	n/a	MCF/yr
Cost Savings:	$ 1,022	/yr
Implementation Cost:	$ 2,592	
Simple Payback:	2.5	Years
Savings to Investment: Ratio (SIR):	4.46	

ECO DESCRIPTION:

Currently, low efficiency lighting systems are in use. This ECO will update the lighting systems to improve efficiency while maintaining or increasing the current light levels. The existing lighting system and proposed retrofit action are as follows:

QTY	FIXTURE TYPE	ACTION
2	1-Lamp, 4' Fluor.	Retrofit with T8 lamps and elect. ballasts.
20	2-Lamp, 4' Fluor.	Retrofit with T8 lamps and elect. ballasts.
20	4-Lamp, 4' Fluor.	Retrofit with T8 lamps and elect. ballasts.
14	Incandescent downlights	Retrofit with compact fluor. lamps.

COST SAVINGS CALCULATIONS:

(Refer to following Flex Output)

$$
\begin{aligned}
\mathit{Demand\ Savings} &= (6.544\,KWH - 4.052\,KWH) x 4\,mo. x \$7.50 + (6.544 - 4.052) x 8\,mo. x \$6.25 \\
&= \$199.36/yr
\end{aligned}
$$

IMPLEMENTATION COSTS:

(Refer to following Flex Output and Lighting Implementation Cost located in Appendix E)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 1387 – ECO VII D. & IX A., C., D. – LIGHTING IMPROVEMENTS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$2,324		
B. SIOH	$128		
C. DESIGN COST	$139		
D. TOTAL COST (1A+1B+1C)	$2,591		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$2,591

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	27.64	$292	11.77	$3,432
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	0.00	$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. COOLING	$10.55	38.27	$404	11.12	$4,490
M. DEMAND SAVINGS			$199	11.12	$2,217
N. TOTAL		65.91	$895		$10,139

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$127		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$1,410

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV- INGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $1,410

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 2.5 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $11,548

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 4.46

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 14.9%

ENERGY CONSERVATION ANALYSIS

BUILDING 1395 - NCE CLUB

Building 1395 is a one story rock building consisting of 26,000 square feet. This facility contains a full service kitchen and a large ballroom/dining area which consists of 6,000 square feet.

The operating hours are from 10:00 am to 10:00 pm Monday thru Friday and 10:00 am to 12:00 midnight on Saturday.

The lighting systems in the dining/ballroom are primarily incandescents with dimmers. The kitchen area lighting system is primarily fluorescent.

The mechanical system consists of multizone air handling units served by one air cooled reciprocating chiller and one water cooled centrifugal chiller. Heating is supplied by a gas fired boiler in the main mechanical room.

Hot water is provided by a gas fired water heater located in the main mechanical room. Dishwashing is accomplished using an automatic dishwasher with an electric hot water booster heater.

The following ECO's are recommended for Building 1395:

1. IV.D. 1) - Replace chiller with higher EFF/CFC free chiller
2. VII. D - Reduce indoor/outdoor lighting to AEI levels
3. IX A. - Replace incandescent lamps with compact fluorescents
4. IX C. - Replace standard lamps with energy saving lamps
5. IX D. - Replace standard ballast with energy saving ballast

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 1395

ECO NO: IV.D 1)

ECO NAME: Replace chiller with higher efficiency, CFC free chiller.

SUMMARY DATA (DEPENDENT):

KWH Savings:	123,020	KWH/yr
Demand Savings:	1,152	KW/yr
Gas Savings:	n/a	MCF/yr
Cost Savings:	$ 12,302	/yr
Implementation Cost:	$ 159,262	
Simple Payback:	8.2	Years
Savings to Investment: Ratio (SIR):	1.81	

ECO DESCRIPTION:

Currently, two chillers serve Building 1395. One is an 80 ton air cooled chiller with an efficiency of 1.33 KW/ton which was installed in 1986. The other chiller is a 160 ton water cooled centrifugal chiller with an efficiency of 1.04 KW/ton which was installed in 1968. The air cooled chiller utilizes R-22 refrigerant and the water cooled chiller utilizes R-11 refrigerant. This ECO analyzes replacing these two chillers with one 234 ton, CFC free, high efficiency, water cooled chiller with an efficiency of .632 KW/ton.

The new chiller should be specified with part-load operation down to 10% of the maximum chiller output to provide adequate turndown. Currently, there is not redundance or back-up capacity due to the fact that the existing chillers serve separate areas. This ECO accounts for the interdependencies related to the UMCS system and the proposed lighting retrofit.

COST SAVINGS CALCULATIONS:

(Refer to following Trace Output)

$$\textit{Demand Savings} = (495\,KW - 396\,KW) \times 4\,mo. \times \$7.50/KW + (495\,KW - 396\,KW) \times 8\,mo. \times \$6.50/KW$$
$$= \$8{,}118/yr$$

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 1395 – ECO IV. D. 1) – REPLACE CHILLER W/ HIGHER EFF/CFC FREE CHILLEF
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 20 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$142,836		
B. SIOH	$7,856		
C. DESIGN COST	$8,570		
D. TOTAL COST (1A+1B+1C)	$159,262		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$159,262

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	419.87	$4,430	14.65	$64,894
B. DIST			$0	17.70	$0
C. RESID			$0	20.99	$0
D. NG	$3.31	0.00	$0	20.60	$0
E. PPG			$0	13.59	$0
F. COAL			$0	16.32	$0
G. SOLAR			$0	13.59	$0
H. GEOTH			$0	13.59	$0
I. BIOMA			$0	13.59	$0
J. REFUS			$0	13.59	$0
K. WIND			$0	13.59	$0
L. OTHER			$0	13.59	$0
M. DEMAND SAVINGS			$7,872	13.59	$106,980
N. TOTAL		419.87	$12,302		$171,875

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$0		
1. DISCOUNT FACTOR (TABLE A)			
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$0

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(–)

	ITEM	SAVINGS(+) COST(–)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV–INGS(+)COST(–)(4)
a.	WC Chiller	$90,080	1	0.96	$86,477
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	AC Chiller	$51,000	13	0.6	$30,600
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$141,080			$117,077

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $117,077

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 8.2 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $288,951

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 1.81

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 7.1%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 1395

ECO NO: VII D & IX A, C, D

ECO NAME: Improve lighting efficiency.

SUMMARY DATA (DEPENDENT):

KWH Savings:	42,637.0	KWH/yr
Demand Savings:	53.7	KW/yr
Gas Savings:	n/a	MCF/yr
Cost Savings:	$ 2,179	/yr
Implementation Cost:	$ 4,850	
Simple Payback:	2.2	Years
Savings to Investment: Ratio (SIR):	5.08	

ECO DESCRIPTION:

Currently, low efficiency lighting systems are in use. This ECO will update the lighting systems to improve efficiency while maintaining or increasing the current light levels. The existing lighting system and proposed retrofit action are as follows:

QTY	FIXTURE TYPE	ACTION
80	2-Lamp, 4' Fluor.	Retrofit w/T8 lamps and elect. ballasts.
9	Incandescent chandelier	None.
45	Incandescent chandelier	Retrofit w/compact fluor. lamps.
14	Misc. incandescent	None.

COST SAVINGS CALCULATIONS:

(Refer to following Flex Output)

$$\textit{Demand Savings} = (14.053KW - 9.578KW)x4mo.x\$7.50/KW + (14.053KW - 9.578KW)x8mo.\$6.25/KW$$
$$= \$358/yr$$

IMPLEMENTATION COSTS:

(Refer to following Flex Output and Lighting Implementation Cost located in Appendix E)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 1395 – ECO VII D. & IX A., C., D. – LIGHTING IMPROVEMENTS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$4,350		
B. SIOH	$239		
C. DESIGN COST	$261		
D. TOTAL COST (1A+1B+1C)	$4,850		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$4,850

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	61.55	$649	11.77	$7,643
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	0.00	$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. COOLING	$10.55	83.97	$886	11.12	$9,851
M. DEMAND SAVINGS			$358	11.12	$3,981
N. TOTAL		145.52	$1,893		$21,475

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$286		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$3,175

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV-INGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $3,175

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 2.2 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $24,649

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 5.08

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 15.9%

ENERGY CONSERVATION ANALYSIS

BUILDING 1462 - SNACK BAR

Building 1462 is a two story block wall facility consisting of 16,000 square feet. This facility contains a 1,300 square feet snack bar area.

The operating hours for this facility are from 9:00 am to 8:30 pm, Sunday thru Thursday and 9:00 am to 10:30 pm, Friday and Saturday.

The lighting system is primarily fluorescent.

The mechanical system consists of an single zone air handling unit served by an air cooled chiller. Heating is provided by a gas fired boiler.

Hot water is provided to the kitchen by a gas fired water heater. Dishwashing is done by hand using a rinse sink with an electric hot water booster heater.

The following ECO's are recommended for Building 1462:

1. VII. D - Reduce indoor/outdoor lighting to AEI levels
2. IX. B - Replace incandescent exit fixtures with LED
3. IX. C - Replace standard lamps with energy saving lamps
4. IX. D - Replace standard ballast with energy saving ballast

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 1462

ECO NO: VII D & IX B, C, D

ECO NAME: Improve lighting efficiency

SUMMARY DATA (DEPENDENT):

KWH Savings:	8,760	KWH/yr
Demand Savings:	15.38	KW/yr
Gas Savings:	n/a	MCF/yr
Cost Savings:	$ 455	/yr
Implementation Cost:	$ 1,037	
Simple Payback:	2.3	Years
Savings to Investment: Ratio (SIR):	4.96	

ECO DESCRIPTION:

Currently, low efficiency lighting systems are in use. This ECO will update the lighting systems to improve efficiency while maintaining or increasing the current light levels. The existing lighting system and proposed retrofit action are as follows:

QTY	FIXTURE TYPE	ACTION
2	2-Lamp, 4' Fluor.	Retrofit w/T8 lamps and electronic ballasts.
16	4-Lamp, 4" Fluor.	Retrofit w/T8 lamps and electronic ballasts.
2	Incand. Exit	Replace w/LED exit fixture.

COST SAVINGS CALCULATIONS:

(Refer to following Flex Output)

$$Demand\ Savings = (3.264KW - 1.982KW) x 4 mo. \$7.50/KW + (3.264KW - 1.982KW) x 8 mo. x \$6.25/KW$$
$$= \$102.56/yr$$

IMPLEMENTATION COSTS:

(Refer to following Flex Output and Lighting Implementation Cost located in Appendix E)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 1462 – ECO VII D. & IX B., C., D. – LIGHTING IMPROVEMENTS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$930		
B. SIOH	$51		
C. DESIGN COST	$56		
D. TOTAL COST (1A+1B+1C)	$1,037		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$1,037

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	12.58	$133	11.77	$1,562
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	0.00	$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11:12	$0
K. WIND			$0	11.12	$0
L. COOLING	$10.55	17.32	$183	11.12	$2,032
M. DEMAND SAVINGS			$103	11.12	$1,140
N. TOTAL		29.9	$418		$4,734

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$37		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$411

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(-)

	ITEM	SAVINGS(+) COST(-)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAVINGS(+)COST(-)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $411

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 2.3 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $5,145

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 4.96

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 15.7%

ENERGY CONSERVATION ANALYSIS

BUILDING 1520 - RESERVE CENTER

Building 1520 is a two story brick facility consisting of reserve unit offices. This facility contains a full service kitchen and large dining area which consists of 4,300 square feet.

The operating hours for the dining and kitchen facility are very sporadic due to the fact that it is used only for mobilization. However, the dining area is used as a break room and from 8:00 am to 4:00 pm the lights are on.

The lighting system is primarily fluorescent.

The mechanical system consists of a packaged DX rooftop air handling unit with gas heating.

Hot water is provided to the kitchen by a gas fired water heater.

Due to the operating conditions for this facility are as follows:

1. VII.D - Reduce indoor/outdoor lighting to AEI levels.
2. IX.A - Replace incandescent lamps with compact fluorescents.
3. IX.B. - Replace incandescent exit fixtures with LED.
4. IX.C. - Replace standard lamps with energy saving lamps.
5. IX.D. - Replace standard ballast with energy saving ballast.

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 1520

ECO NO: VII D & IX A, B, C, D

ECO NAME: Improve lighting efficiency.

SUMMARY DATA (DEPENDENT):

KWH Savings:	12,030	KWH/yr
Demand Savings:	26.76	KW/yr
Gas Savings:	n/a	MCF/yr
Cost Savings:	$ 664	/yr
Implementation Cost:	$ 2,447	
Simple Payback:	3.7	Years
Savings to Investment: Ratio (SIR):	3.06	

ECO DESCRIPTION:

Currently, low efficiency lighting systems are in use. This ECO will update the lighting systems to improve efficiency while maintaining or increasing the current light levels. The existing lighting system and proposed retrofit action are as follows:

QTY	FIXTURE TYPE	ACTION
15	2-Lamp, 4' Fluor.	Retrofit w/T8 lamps and electronic ballasts.
30	3-Lamp, 4' Fluor.	Retrofit w/T8 lamps and electronic ballasts.
4	Incand. Exit	Replace w/LED exit fixture.

COST SAVINGS CALCULATIONS:

(Refer to following Flex Output)

$$\begin{aligned} \textit{Demand Savings} &= (5.91\,KW - 3.68\,KW)x4\,mo.x\$7.50/KW + (5.91\,KW - 3.68\,KW)x8\,mo.x\$6.25/KW \\ &= \$178.40/yr \end{aligned}$$

IMPLEMENTATION COSTS:

(Refer to following Flex Output and Lighting Implementation Cost located in Appendix E)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 1520 – ECO VI/FSI D. & IX B., C., D. – LIGHTING IMPROVEMENTS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$2,195		
B. SIOH	$121		
C. DESIGN COST	$132		
D. TOTAL COST (1A+1B+1C)	$2,447		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$2,447

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	17.14	$181	11.77	$2,128
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	0.00	$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. COOLING	$10.55	23.92	$252	11.12	$2,806
M. DEMAND SAVINGS			$178	11.12	$1,984
N. TOTAL		41.06	$612		$6,918

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$52		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$577

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(–)

	ITEM	SAVINGS(+) COST(–)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV–INGS(+)COST(–)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $577

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 3.7 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $7,496

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 3.06

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 12.1%

ENERGY CONSERVATION ANALYSIS

BUILDING 1630 - YOUTH CENTER

Building 1630 is a one story stucco recreational facility. This facility contains a small snack bar which consists of 480 square feet.

The operating hours for this facility are from 4:00 pm to 10:00 pm, Monday thru Friday and 7:00 am to 10:00 pm on Saturdays.

The lighting system is primarily fluorescent.

The mechanical system consists of multizone air handling units with DX cooling coils and an air cooled condensing units. Heating is provided by gas fired boiler.

Hot water is provided to the kitchen by a gas fired water heater.

The only recommended ECO's for this facility are as follows;

1. VII.D - Reduce Indoor/Outdoor Lighting to AEI Levels
2. IX.A - Replace Incandescent Lamps with Compact Fluorescents
3. IX.C - Replace Standard Lamps with Energy Saving Lamps
4. IX.D - Replace Standard Ballast with Energy Saving Ballast

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO 1630

ECO NO: VII D & IX A, C, D

ECO NAME: Improve lighting efficiency.

SUMMARY DATA (DEPENDENT):

KWH Savings:	2,396.7	KWH/yr
Demand Savings:	5.47	KW/yr
Gas Savings:	n/a	MCF/yr
Cost Savings:	$ 133	/yr
Implementation Cost:	$ 357	
Simple Payback:	2.7	Years
Savings to Investment: Ratio (SIR):	4.21	

ECO DESCRIPTION:

Currently, low efficiency lighting systems are in use. This ECO will update the lighting systems to improve efficiency while maintaining or increasing the current lighting levels. The existing lighting system and proposed retrofit action are as follows:

QTY	FIXTURE TYPE	ACTION
6	4-Lamp, 4' Fluor.	Retrofit w/T8 lamps and electronic ballasts.
1	Bare incandescent	None.

COST SAVINGS CALCULATIONS:

(Refer to following Flex Output)

$$\textit{Demand Savings} = (1.252KW - .796KW)x4mo.x\$7.50/KW + (1.252KW - .796KW)x8mo.x\$6.25/KW$$
$$= \$36.48/yr$$

IMPLEMENTATION COSTS:

(Refer to following Flex Output and Lighting Implementation Cost located in Appendix E)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 1630 – ECO VII D. & IX A., C., D. – LIGHTING IMPROVEMENTS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$320		
B. SIOH	$18		
C. DESIGN COST	$19		
D. TOTAL COST (1A+1B+1C)	$357		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$357

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	3.55	$37	11.77	$441
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	0.00	$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. COOLING	$10.55	4.63	$49	11.12	$543
M. DEMAND SAVINGS			$36	11.12	$406
N. TOTAL		8.18	$123		$1,390

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$10		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$111

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(–)

	ITEM	SAVINGS(+) COST(–)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV–INGS(+)COST(–)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $111

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 2.7 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $1,501

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 4.21

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 14.5%

ENERGY CONSERVATION ANALYSIS

BUILDING 2265 - MESS HALL IN BARRACKS

Building 2265 is a three story barracks consisting of 106,000 square feet. This facility contains a large full service kitchen and dining area which consists of 4,100 square feet.

The operating hours for this facility are from 5:00 am to 8:00 pm, Monday to Friday and 7:00 am to 8:00 pm Saturday and Sunday.

The lighting system is primarily fluorescent.

The mechanical system consists of single zone air handling units served by a water cooled centrifugal chiller located in the basement. Heating is provided by gas fired boilers.

Hot water is provided to the kitchen by a gas fired water heater. Dishwashing is accomplished using an automatic dishwasher with an electric hot water booster heater.

The following ECO's are recommended for Building 2265:

1. IV. D.1) - Replace chiller with higher EFF/CFC free chiller
2. VII. C. - Remove unneeded lamps or fixtures
3. VII. D. - Reduce indoor/outdoor lighting to AEI levels
4. IX. B. - Replace incandescent exit fixtures with LED
5. IX. C. - Replace standard lamps with energy saving lamps
6. IX. D. - Replace standard ballast with energy saving ballast

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 2265

ECO NO: IV. D 1)

ECO NAME: Replace chiller with higher efficiency CFC free chiller.

SUMMARY DATA (DEPENDENT):

KWH Savings:	424,595	KWH/yr
Demand Savings:	1,740	KW/yr
Gas Savings:	n/a	MCF/yr
Cost Savings:	$ 26,888	/yr
Implementation Cost:	$ 338,516	
Simple Payback:	7.7	Years
Savings to Investment: Ratio (SIR):	2.02	

ECO DESCRIPTION:

Currently, a 657 ton water cooled centrifugal chiller is in use. This chiller was installed in 1973 and operates at an efficiency of approximately .871 KW/ton. This ECO analyzes replacing this unit with a new high efficiency, CFC free chiller. The new chillers will operate with an efficiency of approximately .540 KW/ton (see following selection). This ECO analysis accounts for the interdependencies related to operating hours and the proposed lighting retrofit.

COST SAVINGS CALCULATIONS:

(Refer to following Trace Output)

$$\begin{aligned} \textit{Demand Savings} &= (907KW-792KW)x4mo.x\$7.50/KW+(907KW-792KW)x8mo.x\$6.25/KW \\ &= \$9{,}200/yr \end{aligned}$$

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2265 – ECO IV. D. 1) – REPLACE CHILLER W/ HIGHER EFF/CFC FREE CHILLEF
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 20 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$536,040		
B. SIOH	$29,482		
C. DESIGN COST	$32,162		
D. TOTAL COST (1A+1B+1C)	$597,685		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$597,685

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	1449.1	$15,288	14.65	$223,969
B. DIST			$0	17.70	$0
C. RESID			$0	20.99	$0
D. NG	$3.31	0.00	$0	20.60	$0
E. PPG			$0	13.59	$0
F. COAL			$0	16.32	$0
G. SOLAR			$0	13.59	$0
H. GEOTH			$0	13.59	$0
I. BIOMA			$0	13.59	$0
J. REFUS			$0	13.59	$0
K. WIND			$0	13.59	$0
L. OTHER			$0	13.59	$0
M. DEMAND SAVINGS			$11,600	13.59	$157,644
N. TOTAL		1449.1	$26,888		$381,613

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$0		
1. DISCOUNT FACTOR (TABLE A)			
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$0

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAVINGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	Chiller	$338,516	3	0.89	$301,279
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$338,516			$301,279

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $301,279

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 13.6 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $682,893

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 1.14

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 4.7%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 2265

ECO NO: VII C, D & IX B, C, D

ECO NAME: Improve lighting efficiency.

SUMMARY DATA (DEPENDENT):

KWH Savings:	49,856.4	KWH/yr
Demand Savings:	46.7	KW/yr
Gas Savings:	n/a	MCF/yr
Cost Savings:	$ 2,349	/yr
Implementation Cost:	$ 2,723	
Simple Payback:	1.2	Years
Savings to Investment: Ratio (SIR):	9.77	

ECO DESCRIPTION:

Currently, low efficiency lighting systems are in use. This ECO will update the lighting systems to improve efficiency while maintaining or increasing the current light levels. The existing lighting system and proposed retrofit action are as follows:

QTY	FIXTURE TYPE	ACTION
2	2-Lamp, 2' Fluor.	Retrofit w/T8 lamps and electronic ballasts.
58	2-Lamp, 4' Fluor.	Remove 16 fixtures along window area and retrofit remaining with T8 lamps and electronic ballasts.
12	4-Lamp, 4' Fluor.	Retrofit w/T8 lamps and electronic ballasts.
4	Incand. Exit	Replace /LED exit fixtures.

COST SAVINGS CALCULATIONS:

(Refer to following Flex Output)

$$\begin{aligned} \textit{Demand Savings} &= (8.065\,KW - 4.171\,KW)(4\,mo.x\$17.50/KW + 8\,mo.\$6.25/KW) \\ &= \$311.52/yr \end{aligned}$$

IMPLEMENTATION COSTS:

(Refer to following Flex Output and Lighting Implementation Cost located in Appendix E)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2265 – ECO VII C., D. & IX A., B., C., D. – LIGHTING IMPROVEMENTS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$2,442		
B. SIOH	$134		
C. DESIGN COST	$147		
D. TOTAL COST (1A+1B+1C)	$2,723		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$2,723

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	71.24	$752	11.77	$8,846
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	0.00	$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. COOLING	$10.55	98.92	$1,044	11.12	$11,605
M. DEMAND SAVINGS			$312	11.12	$3,469
N. TOTAL		170.16	$2,107		$23,920

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$242		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$2,686

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV-INGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $2,686

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 1.2 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $26,607

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 9.77

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 21.1%

ENERGY CONSERVATION ANALYSIS

BUILDING 2399 - HOSPITAL MESS HALL

Building 2399 is a single story stucco building consisting of a total area of 26,000 square feet. This facility contains a full service kitchen and a large dining area which consists of 14,700 square feet.

The operating hours are from 5:00 am to 8:00 pm, seven days per week.

The lighting system is primarily fluorescent.

The mechanical system consists of fan coil units above the ceiling served by the central hospital water cooled chillers. Heating is provided by three central gas fired, steam boilers.

Hot water is provided to the kitchen by a steam to hot water heat exchanger and a 300 gallon storage tank. Dishwashing is accomplished using an automatic dishwasher with an electric hot water booster heater.

The following ECO's are recommended for Building 2399:

1. IV. A. - Night setback/setup thermostat
2. IV. D.1) - Replace chiller with higher EFF/CFC free chiller
3. IV. F. - Install make-up air supply for kitchen areas
4. VII. D. - Reduce indoor/outdoor lighting to AEI levels
5. IX. A. - Replace incandescent lamps with compact fluorescents
6. IX. B. - Replace incandescent exit fixtures with LED
7. IX. C. - Replace standard lamps with energy saving lamps
8. IX. D. - Replace standard ballast with energy saving ballast

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 2399

ECO NO: IV. A.

ECO NAME: Night setback/setup thermostat.

SUMMARY DATA (DEPENDENT):

KWH Savings:	7,528	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	89.1	MCF/yr
Cost Savings:	$ 575	/yr
Implementation Cost:	$ 363	
Simple Payback:	.6	Years
Savings to Investment: Ratio (SIR):	21.61	

ECO DESCRIPTION:

Currently, manual thermostats are used to control the existing fan coil units that serve the dining and office areas. Each fan coil unit is controlled by a separate thermostat. This ECO analyzes the installation of a programmable night setback/setup thermostats to reduce energy consumption during unoccupied periods.

COST SAVINGS CALCULATIONS:

(Refer to following SimpCalc)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

MAINTENANCE COSTS:

Maintenance costs of $5.00/year is included in the LCCA for programming, battery replacement and failures.

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2399 – ECO IV. A. – NIGHT SETBACK/SETUP THERMOSTAT
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$326		
B. SIOH	$18		
C. DESIGN COST	$20		
D. TOTAL COST (1A+1B+1C)	$363		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$363

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	25.69	$271	11.77	$3,190
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	91.86	$304	15.34	$4,664
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. OTHER			$0	11.12	$0
M. DEMAND SAVINGS			$0	11.12	$0
N. TOTAL		117.55	$575		$7,854

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	($15)		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			($167)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(-)

	ITEM	SAVINGS(+) COST(-)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV-INGS(+)COST(-)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) ($167)

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 0.6 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $7,688

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 21.15

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 27.5%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's)- BUILDING 2399

ECO NO: IV.D.1)

ECO NAME: Replace chiller with higher efficiency, CFC free chiller.

SUMMARY DATA (DEPENDENT):

KWH Savings:	926,098	KWH/yr
Demand Savings:	3,192	KW/yr
Gas Savings:	n/a	MCF/yr
Cost Savings:	$ 54,626	/yr
Implementation Cost:	$ 365,824	
Simple Payback:	5.1	Years
Savings to Investment: Ratio (SIR):	3.02	

ECO DESCRIPTION:

Currently, two 436 ton water cooled centrifugal chillers are in use. These chillers serve Building 2399 and 2376 (hospital) and were installed in 1968. These chillers operate at an efficiency of 1.084 KW/ton and have 80% demand limiting setpoints. This ECO analyzes replacement of the two, 436 ton chillers with one 710 ton high efficiency, CFC free chiller. This would allow one of the 436 ton chillers to remain as back-up and the refrigerant from the demolition chiller could be recovered for future use. The new chiller will operate at an efficiency of approximately .539 KW/ton. This ECO analysis accounts for the operating hours and for the proposed lighting retrofit.

COST SAVINGS CALCULATIONS:

(Refer to following Flex Output)

$$\textit{Demand Savings} = (1{,}939\,KW - 1{,}842\,KW)(4\,mo.x\$7.50/KW + 8\,mo.x\$6.25/KW)$$
$$= \$7{,}760/yr$$

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2399 – ECO IV. D. 1) – REPLACE CHILLER W/ HIGHER EFF/CFC FREE CHILLEF
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 20 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$328,093		
B. SIOH	$18,045		
C. DESIGN COST	$19,686		
D. TOTAL COST (1A+1B+1C)	$365,824		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$365,824

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	3160.8	$33,346	14.65	$488,525
B. DIST			$0	17.70	$0
C. RESID			$0	20.99	$0
D. NG	$3.31	0.00	$0	20.60	$0
E. PPG			$0	13.59	$0
F. COAL			$0	16.32	$0
G. SOLAR			$0	13.59	$0
H. GEOTH			$0	13.59	$0
I. BIOMA			$0	13.59	$0
J. REFUS			$0	13.59	$0
K. WIND			$0	13.59	$0
L. OTHER			$0	13.59	$0
M. DEMAND SAVINGS			$21,280	13.59	$289,195
N. TOTAL		3160.8	$54,626		$777,721

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$0		
1. DISCOUNT FACTOR (TABLE A)			
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$0

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV- INGS(+)COST(−)(4)
a.	Chillers	$339,208	1	0.96	$325,640
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$339,208			$325,640

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $325,640

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 5.1 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $1,103,360

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 3.02

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 9.9%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 2399

ECO NO: IV.F.1

ECO NAME: Install make-up air supply for kitchen areas.

SUMMARY DATA (DEPENDENT):

KWH Savings:	41,614	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	617.0	MCF/yr
Cost Savings:	$ 3,604	/yr
Implementation Cost:	$ 31,268	
Simple Payback:	8.7	Years
Savings to Investment: Ratio (SIR):	2.09	

ECO DESCRIPTION:

Currently, a 10' x 28' kitchen hood is in use which does not include make-up air supply. As a result, approximately 40% of the exhaust during cooling months is drawn from the adjacent conditioned dining room. The kitchen and dining areas are both heated during heating months and 100% of the make-up air for the hood is brought in from outside. This ECO analyzes installing a make-up air hood with 70% supply air make-up.

COST SAVINGS CALCULATIONS:

(Refer to following spreadsheet)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2399 – ECO IV. F.) – INSTALL MAKE–UP AIR SUPPLY FOR KITCHEN AREAS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 20 PREPARER C. M. JOHNSON

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$28,043		
B. SIOH	$1,542		
C. DESIGN COST	$1,683		
D. TOTAL COST (1A+1B+1C)	$31,268		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$31,268

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	142.03	$1,498	14.65	$21,952
B. DIST			$0	17.70	$0
C. RESID			$0	20.99	$0
D. NG	$3.31	636.08	$2,105	20.60	$43,372
E. PPG			$0	13.59	$0
F. COAL			$0	16.32	$0
G. SOLAR			$0	13.59	$0
H. GEOTH			$0	13.59	$0
I. BIOMA			$0	13.59	$0
J. REFUS			$0	13.59	$0
K. WIND			$0	13.59	$0
L. OTHER			$0	13.59	$0
M. DEMAND SAVINGS			$0	13.59	$0
N. TOTAL		778.11	$3,604		$65,324

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$0		
1. DISCOUNT FACTOR (TABLE A)			
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$0

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV-INGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $0

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 8.7 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $65,324

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 2.09

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 7.9%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 2399

ECO NO: IV.F.2

ECO NAME: Install make-up air supply for kitchen areas.

SUMMARY DATA (DEPENDENT):

KWH Savings:	4,776	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	70.8	MCF/yr
Cost Savings:	$ 414	/yr
Implementation Cost:	$ 3,976	
Simple Payback:	9.6	Years
Savings to Investment: Ratio (SIR):	1.89	

ECO DESCRIPTION:

Currently, a 4' x 4' kitchen hood is in use which does not include make-up air supply. As a result, approximately 40% of the exhaust during cooling months is drawn from the adjacent conditioned dining room. The kitchen and dining areas are both heated during heating months and 100% of the make-up air for the hood is brought in from outside. This ECO analyzes installing a make-up air hood with 70% supply air make-up.

COST SAVINGS CALCULATIONS:

(Refer to following spreadsheet)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2399 – ECO IV. F.) – INSTALL MAKE–UP AIR SUPPLY FOR KITCHEN AREAS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 20 PREPARER C. M. JOHNSON

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$3,566		
B. SIOH	$196		
C. DESIGN COST	$214		
D. TOTAL COST (1A+1B+1C)	$3,976		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$3,976

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	16.3	$172	14.65	$2,519
B. DIST			$0	17.70	$0
C. RESID			$0	20.99	$0
D. NG	$3.31	73.02	$242	20.60	$4,979
E. PPG			$0	13.59	$0
F. COAL			$0	16.32	$0
G. SOLAR			$0	13.59	$0
H. GEOTH			$0	13.59	$0
I. BIOMA			$0	13.59	$0
J. REFUS			$0	13.59	$0
K. WIND			$0	13.59	$0
L. OTHER			$0	13.59	$0
M. DEMAND SAVINGS			$0	13.59	$0
N. TOTAL		89.32	$414		$7,498

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$0		
1. DISCOUNT FACTOR (TABLE A)			
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$0

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV-INGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $0

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 9.6 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $7,498

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 1.89

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 7.4%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 2399

ECO NO: VII D & IX A, B, C, D

ECO NAME: Improve lighting efficiency.

SUMMARY DATA (DEPENDENT):

KWH Savings:	18,019	KWH/yr
Demand Savings:	28.42	KW/yr
Gas Savings:	n/a	MCF/yr
Cost Savings:	$ 1,574.00	/yr
Implementation Cost:	$ 8,895	
Simple Payback:	5.7	Years
Savings to Investment: Ratio (SIR):	2.00	

ECO DESCRIPTION:

Currently, low efficiency lighting systems are in use. This ECO will update the lighting systems to improve efficiency while maintaining or increasing the current light levels. The existing lighting system and proposed retrofit action are as follows:

QTY	FIXTURE TYPE	ACTION
6	2-Lamp, 2' Fluor.	Retrofit w/T8 lamps and electronic ballasts.
158	2-Lamp, 4' Fluor.	Retrofit w/T8 lamps and electronic ballasts.
10	4-Lamp, 4' Fluor.	Retrofit w/T8 lamps and electronic ballasts.
2	Incandescent track	Retrofit with compact fluor. lamps.
10	Incandescent hood	None.
2	Incandescent exit	Replace w/LED exit fixture.

COST SAVINGS CALCULATIONS:

(Refer to following Flex Output)

$$
\begin{aligned}
Demand\ Savings &= (18.392KW - 16.024KW)(4mo.x\$7.50/KW + 8mo.x\$6.25/KW) \\
&= \$189.44/yr
\end{aligned}
$$

IMPLEMENTATION COSTS:

(Refer to following Flex Output and Lighting Implementation Cost located in Appendix E)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2399 – ECO VII D. & IX A., B., C., D. – LIGHITNG IMPROVEMENTS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$7,978		
B. SIOH	$439		
C. DESIGN COST	$479		
D. TOTAL COST (1A+1B+1C)	$8,895		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$8,895

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	44.25	$467	11.77	$5,495
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	0.00	$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. COOLING	$10.55	61.5	$649	11.12	$7,215
M. DEMAND SAVINGS			$189	11.12	$2,107
N. TOTAL		105.75	$1,305		$14,816

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$269		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$2,986

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(–)

	ITEM	SAVINGS(+) COST(–)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAVINGS(+)COST(–)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $2,986

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 5.7 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $17,802

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 2.00

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 8.9%

ENERGY CONSERVATION ANALYSIS

BUILDING 2521 - BOWLING CENTER

Building 2521 is a single story brick facility consisting of 21,000 square feet. This facility contains a small snack bar area which consists of 1,100 square feet.

The operating hours are from 7:00 am to 12:00 am, seven days per week.

The lighting system is primarily fluorescent.

The mechanical system consists of packaged DX rooftop air handling units with gas furnaces.

Hot water is provided to the kitchen by a gas fired water heater. No automatic dishwashing equipment is utilized.

The following ECO's are recommended for Building 2521:

1. IV. A - Night setback/setup thermostat
2. VII. D - Reduce indoor/outdoor lighting to AEI levels
3. IX. A - Replace incandescent lamps with compact fluorescents
4. IX. C - Replace standard lamps with energy saving lamps
5. IX. D - Replace standard ballast with energy saving ballast

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 2521

ECO NO: IV. A.

ECO NAME: Night setback/setup thermostat.

SUMMARY DATA (DEPENDENT):

KWH Savings:	278	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	2.1	MCF/yr
Cost Savings:	$ 17	/yr
Implementation Cost:	$ 122	
Simple Payback:	7.1	Years
Savings to Investment: Ratio (SIR):	1.88	

ECO DESCRIPTION:

Currently, a manual thermostat is used to control the existing air handling unit which serves the snack bar area. This ECO analyzes the installation of a programmable night setback/setup thermostat to reduce energy consumption during unoccupied periods.

COST SAVINGS CALCULATIONS:

(Refer to following SimpCalc)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

MAINTENANCE COSTS:

Maintenance costs of $5.00/year is included in the LCCA for programming, battery replacement and failures.

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2521 – ECO IV. A. – NIGHT SETBACK/SETUP THERMOSTAT
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$109		
B. SIOH	$6		
C. DESIGN COST	$7		
D. TOTAL COST (1A+1B+1C)	$122		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$122

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	0.949	$10	11.77	$118
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	2.17	$7	15.34	$110
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. OTHER			$0	11.12	$0
M. DEMAND SAVINGS			$0	11.12	$0
N. TOTAL		3.119	$17		$228

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	($5)		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			($56)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV- INGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) ($56)

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 10.0 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $173

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 1.42

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 6.5%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 2521

ECO NO: VII D & IX A, C, D

ECO NAME: Improve lighting efficiency.

SUMMARY DATA (DEPENDENT):

KWH Savings:	2994	KWH/yr
Demand Savings:	13.3	KW/yr
Gas Savings:	n/a	MCF/yr
Cost Savings:	$ 212	/yr
Implementation Cost:	$ 866	
Simple Payback:	4.1	Years
Savings to Investment: Ratio (SIR):	2.75	

ECO DESCRIPTION:

Currently, low efficiency lighting systems are in use. This ECO will update the lighting systems to improve efficiency while maintaining or increasing the current light levels. The existing lighting system and proposed retrofit action are as follows:

QTY	FIXTURE TYPE	ACTION
2	2-Lamp, 4' Fluor	Retrofit w/T8 lamps and electronic ballasts.
9	4-Lamp, 4' Fluor.	Retrofit w/T8 lamps and electronic ballasts.
10	Incand. downlight	Retrofit with compact fluor. lamps

COST SAVINGS CALCULATIONS:

(Refer to following Flex Output and Lighting Implementation Cost located in Appendix E)

$$
\begin{aligned}
\textit{Demand Savings} &= (2.52\,KW - 1.41\,KW)(4\,mo.x\$7.50/KW + 8\,mo.x\$6.25/KW) \\
&= \$88.8/yr
\end{aligned}
$$

IMPLEMENTATION COSTS:

(Refer to following Flex Output)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2521 – ECO VII D. & IX A., C., D. – LIGHTING IMPROVEMENTS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$777		
B. SIOH	$43		
C. DESIGN COST	$47		
D. TOTAL COST (1A+1B+1C)	$866		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$866

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	4.26	$45	11.77	$529
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	0.00	$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. COOLING	$10.55	5.96	$63	11.12	$699
M. DEMAND SAVINGS			$89	11.12	$987
N. TOTAL		10.22	$197		$2,216

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$15		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$167

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(–)

	ITEM	SAVINGS(+) COST(–)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAVINGS(+)COST(–)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $167

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 4.1 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $2,382

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 2.75

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 11.3%

ENERGY CONSERVATION ANALYSIS

BUILDING 2530 - CHILD CARE CENTER

Building 2530 is a single story stucco building which is utilized as an elementary education facility. This facility contains a small, 700 square feet kitchen and dining is in the individual classrooms.

The operating hours are 6:00 am to 6:00 pm, Monday thru Friday.

The lighting system is primarily fluorescent.

The mechanical system consists of water source heat pumps served by an evaporative condenser. Heating is provided by a gas fired boiler.

Hot water is provided to the kitchen by the domestic gas fired water heater. Dishwashing is accomplished using an automatic dishwasher with an electric hot water booster heater.

This facility was constructed in 1989 and the design included many energy efficient features. Therefore, the only recommended ECO's for this facility are to improve lighting efficiency (ie. VII. D and IX. B, C, D).

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 2530

ECO NO: VII D & IX B, C, D

ECO NAME: Improve lighting efficiency.

SUMMARY DATA (DEPENDENT):

KWH Savings:	5,444	KWH/yr
Demand Savings:	9.1	KW/yr
Gas Savings:	n/a	MCF/yr
Cost Savings:	$ 280	/yr
Implementation Cost:	$ 591	
Simple Payback:	2.1	Years
Savings to Investment: Ratio (SIR):	5.36	

ECO DESCRIPTION:

Currently, low efficiency lighting systems are in use. This ECO will update the lighting systems to improve efficiency while maintaining or increasing the current light levels. The existing lighting system and proposed retrofit action are as follows:

QTY	FIXTURE TYPE	ACTION
10	4-Lamp, 4' Fluor.	Retrofit w/T8 lamps and electronic ballasts.
1	Incand. Exit	Replace w/LED exit fixture

COST SAVINGS CALCULATIONS:

(Refer to following Flex Output)

$$\textit{Demand Savings} = (1.92KW - 1.16KW)(4mo.x\$7.50/KW + 8mo.\$6.25/KW)$$
$$= \$60.80/yr$$

IMPLEMENTATION COSTS:

(Refer to following Flex Output and Lighting Implementation Cost located in Appendix E)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2530 – ECO VII D. & IX A., B., C., D. – LIGHTING IMPROVEMENTS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$530		
B. SIOH	$29		
C. DESIGN COST	$32		
D. TOTAL COST (1A+1B+1C)	$591		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$591

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	7.78	$82	11.77	$966
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	0.00	$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. COOLING	$10.55	10.8	$114	11.12	$1,267
M. DEMAND SAVINGS			$61	11.12	$678
N. TOTAL		18.58	$257		$2,911

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$23		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$255

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(–)

	ITEM	SAVINGS(+) COST(–)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV–INGS(+)COST(–)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $255

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 2.1 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $3,167

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 5.36

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 16.3%

ENERGY CONSERVATION ANALYSIS

BUILDING 2652 - DINNER THEATRE

Building 2652 is a two story brick facility consisting of 31,000 square feet. This facility contains a full service kitchen and a large dinner theatre which consists of 3,600 square feet.

The operating hours are from 10:00 am to 12:00 am, Wednesday thru Saturday.

The lighting system is primarily fluorescent in the kitchen area and incandescent with dimming in the theatre.

The mechanical system consist of fan coil units served by an air cooled chiller. Heating is provided by gas fired duct heaters located in the plenum space above the theatre.

Hot water is provided to the kitchen by a gas fired water heater. Dishwashing is accomplished using an automatic dishwasher with an electric hot water booster heater.

The following ECO's are recommended for Building 2652:

1. IV. C.1) - Add stop/start function to HVAC equipment
2. VII. D - Reduce indoor/outdoor lighting to AEI levels
3. IX. A - Replace incandescent lamps with compact fluorescents
4. IX. B - Replace incandescent exit fixtures with LED
5. IX. C - Replace standard lamps with energy saving lamps
6. IX. D - Replace standard ballast with energy saving ballast

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 2652

ECO NO: IV. C. 1)

ECO NAME: Add stop/start function to HVAC equipment.

SUMMARY DATA (DEPENDENT):

KWH Savings:	41,114	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	39.0	MCF/yr
Cost Savings:	$ 1,613	/yr
Implementation Cost:	$ 2,292	
Simple Payback:	1.4	Years
Savings to Investment: Ratio (SIR):	8.49	

ECO DESCRIPTION:

Presently, the mechanical systems are not controlled during unoccupied times. This ECO analyzes the addition of timeclocks and relays to shut down the HVAC systems during unoccupied hours.

COST SAVINGS CALCULATIONS:

(Refer to following SimpCalc Output)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

MAINTENANCE COSTS:

Maintenance costs of $15/year for each timeclock included in the LCCA for adjustments and failures.

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2652 – ECO IV. C. 1) – ADD STOP/START FUNCTION TO HVAC EQUIPMENT
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$2,056		
B. SIOH	$113		
C. DESIGN COST	$123		
D. TOTAL COST (1A+1B+1C)	$2,292		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$2,292

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	140.32	$1,480	11.77	$17,424
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	40.21	$133	15.34	$2,042
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. OTHER			$0	11.12	$0
M. DEMAND SAVINGS			$0	11.12	$0
N. TOTAL		180.53	$1,613		$19,466

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	($30)		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			($333)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV-INGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) ($333)

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 1.4 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $19,133

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 8.35

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 19.8%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 2652

ECO NO: VIII D & IX A, B, C, D

ECO NAME: Improve lighting efficiency.

SUMMARY DATA (DEPENDENT):

KWH Savings:	8,090	KWH/yr
Demand Savings:	11.7	KW/yr
Gas Savings:	n/a	MCF/yr
Cost Savings:	$ 406	/yr
Implementation Cost:	$ 1,588	
Simple Payback:	3.9	Years
Savings to Investment: Ratio (SIR):	2.89	

ECO DESCRIPTION:

Currently, low efficiency lighting systems are in use. This ECO will update the lighting systems to improve efficiency while maintaining or increasing the current light levels. The existing lighting system and proposed retrofit action are as follows:

QTY	FIXTURE TYPE	ACTION
2	2-Lamp, 4" Fluor.	Retrofit w/T8 lamps and electronic ballasts.
12	4-Lamp, 4' Fluor.	Retrofit w/T8 lamps and electronic ballasts.
7	HID Downlight	None.
51	Incandescent downlight	None (diming required).
2	Incandescent exit	Replace w/LED exit fixture

COST SAVINGS CALCULATIONS:

(Refer to following Flex Output)

$$\begin{aligned} Demand\ Savings &= (7.721\,KW - 6.743\,KW)(4\,mo.x\$7.50/KW + 8\,mo.x\$6.25/KW) \\ &= \$78.24/yr \end{aligned}$$

IMPLEMENTATION COSTS:

(Refer to following Flex Output)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2652 – ECO VII D. & IX A., B., C., D. – LIGHTING IMPROVEMENTS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$1,424		
B. SIOH	$78		
C. DESIGN COST	$85		
D. TOTAL COST (1A+1B+1C)	$1,588		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$1,588

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	11.69	$123	11.77	$1,452
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	0.00	$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. COOLING	$10.55	15.92	$168	11.12	$1,868
M. DEMAND SAVINGS			$78	11.12	$870
N. TOTAL		27.61	$370		$4,189

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$36		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$400

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(–)

	ITEM	SAVINGS(+) COST(–)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV–INGS(+)COST(–)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $400

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 3.9 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $4,589

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 2.89

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 11.6%

ENERGY CONSERVATION ANALYSIS

BUILDING 2841 - ACADEMY DINING

Building 2841 is four story facility consisting of 363,000 square feet. This facility contains a full service kitchen and a large dining area which consists of 8,300 square feet.

The operating hours are from 10:00 am to 1:00 pm, Monday thru Friday.

The lighting system is primarily fluorescent in the kitchen area and incandescent with dimming in the bar and dining areas.

The mechanical system consists of multi-zone air handling units served by water cooled centrifugal chillers. Heating is provided by gas fired boilers.

Hot water is provided to the kitchen by a gas fired boiler located in the basement. Dishwashing is accomplished using an automatic dishwasher with an electric hot water booster heater.

The following ECO's are recommended for Building 2841:

1. IV. A - Night setback/setup thermostat
2. VII. C - Remove unneeded lamps or fixtures
3. VII. D - Reduce indoor/outdoor lighting to AEI levels
4. IX. A - Replace incandescent lamps with compact fluorescents
5. IX. B - Replace incandescent exit fixtures with LED
6. IX. C - Replace standard lamps with energy saving lamps
7. IX. D - Replace standard ballast with energy saving ballast
8. IX. E - Replace existing fixture with high efficiency fixtures

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 2841

ECO NO: IV. A

ECO NAME: Night setback/setup thermostats

SUMMARY DATA (DEPENDENT):

KWH Savings:	2,000	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	23.5	MCF/yr
Cost Savings:	$ 152	/yr
Implementation Cost:	$ 242	
Simple Payback:	1.6	Years
Savings to Investment: Ratio (SIR):	8.59	

ECO DESCRIPTION:

Currently manual thermostats are used to control the existing multizone air handling unit which serves the dining, kitchen and bar areas. The multizone unit is in operation 24 hours per day.. This ECO analyzes the installation of a programmable night setback/setup thermostat to reduce energy consumption during unoccupied periods.

COST SAVINGS CALCULATIONS:

(Refer to following SimpCalc Output)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

MAINTENANCE COSTS:

Maintenance costs of $5.00/year is included in the LCCA for programming, battery replacement and failures.

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2841 – ECO IV. A. – NIGHT SETBACK/SETUP THERMOSTAT
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$217		
B. SIOH	$12		
C. DESIGN COST	$13		
D. TOTAL COST (1A+1B+1C)	$242		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$242

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	6.83	$72	11.77	$848
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	24.23	$80	15.34	$1,230
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. OTHER			$0	11.12	$0
M. DEMAND SAVINGS			$0	11.12	$0
N. TOTAL		31.06	$152		$2,078

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	($10)		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			($111)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV-INGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) ($111)

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 1.7 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $1,967

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 8.13

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 19.6%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 2841

ECO NO: VII C, D & IX A, B, C, D, E.

ECO NAME: Improve lighting efficiency.

SUMMARY DATA (DEPENDENT):

KWH Savings:	111,658	KWH/yr
Demand Savings:	185.9	KW/yr
Gas Savings:	n/a	MCF/yr
Cost Savings:	$ 6,903	/yr
Implementation Cost:	$ 4,343	
Simple Payback:	.6	Years
Savings to Investment: Ratio (SIR):	18.1	

ECO DESCRIPTION:

Currently, low efficiency lighting systems are in use. This ECO will update the lighting systems to improve efficiency while maintaining or increasing the current light levels. The existing lighting system and proposed retrofit action are as follows:

QTY	FIXTURE TYPE	ACTION
16	2-Lamp, 4' Fluor. cove	Remove all.
241	Incandescent downlight	Remove 139 incandescent fixtures and replace w/52 2-Lamp, 4' Fluor.
12	Fan/Light	None
29	2-Lamp, 4' Fluor	Retrofit w/T8 lamps and electronic ballasts.
34	4-Lamp, 4' Fluor	Retrofit w/T8 lamps and electronic ballasts.
7	Incandescent hood	None.
4	Incandescent exit	Replace with LED exit fixture.

COST SAVINGS CALCULATIONS:

(Refer to following Flex Output)

$$\begin{aligned} \textit{Demand Savings} &= (31.26\,KW - 15.77\,KW)(4\,mo.x\$7.50/KW + 8\,mo.x\$6.25/KW) \\ &= \$1{,}239.20/yr \end{aligned}$$

IMPLEMENTATION COSTS:

(Refer to following Flex Output and Lighting Implementation Cost located in Appendix E)

LIFE CYCLE COST ANALYSIS:

Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 2841 – ECO VI C., D. & IX A., B., C., D., E. – LIGHTING IMPROVEMENTS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$3,895		
B. SIOH	$214		
C. DESIGN COST	$234		
D. TOTAL COST (1A+1B+1C)	$4,343		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$4,343

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	158.61	$1,673	11.77	$19,695
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	0.00	$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. COOLING	$10.55	222.48	$2,347	11.12	$26,100
M. DEMAND SAVINGS			$1,239	11.12	$13,780
N. TOTAL		381.09	$5,260		$59,576

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$1,703		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$18,903

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(–)

	ITEM	SAVINGS(+) COST(–)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV–INGS(+)COST(–)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $18,903

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 0.6 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $78,479

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 18.07

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 26.1%

ENERGY CONSERVATION ANALYSIS

BUILDING 5107 - DINING HALL

Building 5107 is a single story frame building consisting of 3,400 square feet. This facility consists of a full service kitchen and a large dining area.

The operating hours for this facility are from 5:30 am to 6:30 pm, seven days per week.

The lighting system is primarily fluorescent.

The mechanical system consists of window air conditioners. Heating is provided by floor mounted gas furnaces.

Hot water is provided to the kitchen by a gas fired water heater. Dishwashing is accomplished using an automatic dishwasher with an electric hot water booster heater.

The following ECO's are recommended for Building 5107:

1. IV. C. 1) - Add stop/start function to HVAC equipment
2. VII. D. - Reduce indoor/outdoor lighting to AEI levels
3. IX. A - Replace incandescent lamps with compact fluorescents
4. IX. B - Replace incandescent exit fixtures with LED
5. IX. C - Replace standard lamps with energy saving lamps
6. IX. D - Replace standard ballast with energy saving ballast

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 5107

ECO NO: IV. C. 1

ECO NAME: Add stop/start function for HVAC equipment.

SUMMARY DATA (DEPENDENT):

KWH Savings:	22,613	KWH/yr
Demand Savings:	0	KW/yr
Gas Savings:	n/a	MCF/yr
Cost Savings:	$ 814	/yr
Implementation Cost:	$ 425	
Simple Payback:	.5	Years
Savings to Investment: Ratio (SIR):	22.56	

ECO DESCRIPTION:

Presently, the mechanical systems are not controlled during unoccupied times. This ECO analyzes the addition of timeclocks and relays to shut down the HVAC systems during unoccupied hours.

COST SAVINGS CALCULATIONS:

(Refer to following SimpCalc Output)

IMPLEMENTATION COSTS:

(Refer to following Cost Estimate)

MAINTENANCE COSTS:

Maintenance costs of $15/year for each timeclock included in the LCCA for adjustments and failures.

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 5107 – ECO IV. C. 1) – ADD STOP/START FUNCTION TO HVAC EQUIPMENT
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$381		
B. SIOH	$21		
C. DESIGN COST	$23		
D. TOTAL COST (1A+1B+1C)	$425		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$425

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	77.18	$814	11.77	$9,584
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	0.00	$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. OTHER			$0	11.12	$0
M. DEMAND SAVINGS			$0	11.12	$0
N. TOTAL		77.18	$814		$9,584

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	–$15		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			–$167

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV-INGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) −$167

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 0.5 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $9,417

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 22.17

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 27.9%

ENERGY CONSERVATION ANALYSIS

ENERGY CONSERVATION OPPORTUNITIES (ECO's) - BUILDING NO. 5107

ECO NO: VII D & IX A, B, C, D

ECO NAME: Improve lighting efficiency.

SUMMARY DATA (DEPENDENT):

KWH Savings:	12,962	KWH/yr
Demand Savings:	18.23	KW/yr
Gas Savings:	n/a	MCF/yr
Cost Savings:	$ 654	/yr
Implementation Cost:	$ 2,119	
Simple Payback:	3.2	Years
Savings to Investment: Ratio (SIR):	3.49	

ECO DESCRIPTION:

Currently, low efficiency lighting systems are in use. This ECO will update the lighting system to improve efficiency while maintaining or increasing lighting levels. The existing lighting system and proposed retrofit action are as follows:

QTY	FIXTURE TYPE	ACTION
46	2-Lamp, 4' Fluor.	Retrofit w/T8 lamps and electronic ballasts.
2	Bare incandescents.	None.
3	Incandescent exit	Replace w/LED exit fixture

COST SAVINGS CALCULATIONS:

(Refer to following Flex Output)

$$\begin{aligned} \textit{Demand Savings} &= (4.976KW - 3.457KW)(4\,mo.x\$7.50/KW + 8\,mo.x\$6.25/KW) \\ &= \$121.52/yr \end{aligned}$$

IMPLEMENTATION COSTS:

(Refer to following Flex Output and Lighting Implementation Cost located in Appendix E)

LIFE CYCLE COST ANALYSIS:

(Refer to following ECIP Life Cycle Cost Summary)

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: FORT SAM HOUSTON REGION NO. 3 , PROJECT NO. 91109912F
PROJECT TITLE: FORT SAM HOUSTON DINING FACILITIES EEAP FISCAL YEAR 1994
DISCRETE PORTION NAME: BUILDING 5107 – ECO VII D. & IX A., B., C., D. – LIGHTING IMPROVEMENTS
ANALYSIS DATE: NOVEMBER 1, 1993 ECONOMIC LIFE 15 PREPARER S. P. CLARK

1. INVESTMENT COSTS:

A. CONSTRUCTION COST	$1,900		
B. SIOH	$105		
C. DESIGN COST	$114		
D. TOTAL COST (1A+1B+1C)	$2,119		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$0	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D–1E–1F)			$2,119

2. ENERGY SAVINGS (+)/COST(–):

DATE OF NISTIR 85–3273–X USED FOR DISCOUNT FACTORS: 'NOVEMBER 4, 1992

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$10.55	18.23	$192	11.77	$2,264
B. DIST			$0	13.83	$0
C. RESID			$0	16.15	$0
D. NG	$3.31	0.00	$0	15.34	$0
E. PPG			$0	11.12	$0
F. COAL			$0	12.82	$0
G. SOLAR			$0	11.12	$0
H. GEOTH			$0	11.12	$0
I. BIOMA			$0	11.12	$0
J. REFUS			$0	11.12	$0
K. WIND			$0	11.12	$0
L. COOLING	$10.55	26.01	$274	11.12	$3,051
M. DEMAND SAVINGS			$122	11.12	$1,351
N. TOTAL		44.24	$588		$6,666

3. NON ENERGY SAVINGS (+) OR COST (–):

A. ANNUAL RECURRING (+/–)	$66		
1. DISCOUNT FACTOR (TABLE A)		11.1	
2. DISCOUNTED SAVINGS/COST (3A X 3A1)			$733

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

B. NON RECURRING SAVINGS (+) OR COST(−)

	ITEM	SAVINGS(+) COST(−)(1)	YEAR OF OCCUR.(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAVINGS(+)COST(−)(4)
a.	N/A	$0	1	0.96	$0
b.	N/A	$0	2	0.92	$0
c.	N/A	$0	3	0.89	$0
d.	N/A	$0	4	0.85	$0
e.	N/A	$0	5	0.82	$0
f.	N/A	$0	6	0.79	$0
g.	N/A	$0	7	0.76	$0
h.	N/A	$0	8	0.73	$0
i.	N/A	$0	9	0.7	$0
j.	N/A	$0	10	0.68	$0
k.	N/A	$0	11	0.65	$0
l.	N/A	$0	12	0.62	$0
m.	N/A	$0	13	0.6	$0
n.	N/A	$0	14	0.58	$0
o.	N/A	$0	15	0.56	$0
p.	TOTAL	$0			$0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (3A2 + 3Bp4) $733

4. SIMPLE PAYBACK 1G/(2N3+3A+(3Bp1/ECONOMIC LIFE)): 3.2 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $7,399

6. SAVINGS TO INVESTMENT RATIO (SIR) 5/1G: 3.49

7. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 13.0%